

EVERYDAY

JULY 1992

ELECTRONICS

G G 070892
BRENTFORD SQ
NEWS 878-1882
10 \$5.50

INCORPORATING ELECTRONICS MONTHLY

£1.60



32 PAGE

GREENWELD

Summer Catalogue Supplement

HOSEPIPE CONTROLLER

ELECTRONIC CRICKET

CLASS "A"

HEADPHONE AMPLIFIER



THE No. 1 INDEPENDENT MAGAZINE for ELECTRONICS, TECHNOLOGY and COMPUTER PROJECTS

AMSTRAD PORTABLE PC'S FROM £149 (PPC1512SD), £179 (PPC1512DD), £179 (PPC1640SD), £209 (PPC1640DD). MODEMS £30 EXTRA. NO MANUALS OR PSU.

HIGH POWER CAR SPEAKERS. Stereo pair output 100w each. 4ohm impedance and consisting of 6 1/2" woofer 2" mid range and 1" tweeter. Ideal to work with the amplifier described above. Price per pair £30.00 Order ref 30P7R.

2KV 500 WATT TRANSFORMERS Suitable for high voltage experiments or as a spare for a microwave oven etc. 250v AC input. Now only £4.00 ref 4P157

MICROWAVE CONTROL PANEL. Mains operated, with touch switches. Complete with 4 digit display, digital clock, and 2 relay outputs one for power and one for pulsed power (programmable). Ideal for all sorts of precision timer applications etc. Now only £4.00 ref 4P151.

FIBRE OPTIC CABLE. Stranded optical fibres sheathed in black PVC. Five metre length £7.00 ref 7P29R

12V SOLAR CELL. 200mA output ideal for trickle charging etc. 300 mm square. Our price £15.00 ref 15P42R

PASSIVE INFRA-RED MOTION SENSOR. Complete with daylight sensor, adjustable lights on timer (8 secs -15 mins), 50' range with a 90 deg coverage. Manual override facility. Complete with wall brackets, bulb holders etc. Brand new and guaranteed. Now only £19.00 ref 19P29

Pack of two PAR38 bulbs for above unit £12.00 ref 12P43R
VIDEO SENDER UNIT Transmit both audio and video signals from either a video camera, video recorder or computer to any standard TV set within a 100' range! (tune TV to a spare channel). 12v DC op. £15.00 ref 15P39R Suitable mains adaptor £5.00 ref 5P191R

FM TRANSMITTER housed in a standard working 13A adapter (bug in mains driven). £26.00 ref 26P2R

MINIATURE RADIO TRANSCIVERS. A pair of walkie talkies with a range of up to 2 kilometres. Units measure 22x52x155mm. Complete with cases. £30.00 ref 30P12R

FM CORDLESS MICROPHONE. Small hand held unit with a 500' range! 2 transmit power levels reqs PP3 battery. Tuneable to any FM receiver. Our price £15 ref 15P42AR

12 BAND COMMUNICATIONS RECEIVER. 9 short bands, FM, AM and LW DX/local switch, tuning 'ey' mains or battery. Complete with shoulder strap and mains lead NOW ONLY £19.00!! REF 19P14R.

CAR STEREO AND FM RADIO. Low cost stereo system giving 5 watts per channel. Signal to noise ratio better than wow and flutter less than .35%. Neg earth. £19.00 ref 19P30

LOW COST WALKIE TALKIES. Pair of battery operated units with a range of about 200'. Our price £8.00 a pair ref 8P50R

7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power amp! 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14R.

NICAD BATTERIES. Brand new top quality. 4 x AA's £4.00 ref 4P44R. 2 x C's £4.00 ref 4P73R. 4 x D's £9.00 ref 9P12R. 1 x PP3 £6.00 ref 6P35R

TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. Latest edition £20.00 ref 20P32R.

CABLE TIES. 142mm x 3.2mm white nylon pack of 100 £3.00 ref 3P104R. Bumper pack of 1,000 ties £14.00 ref 14P6R
GOT A CARAVAN OR BOAT?

NEW 80 PAGE FULL COLOUR LEISURE CATALOGUE
2,500 NEW LINES FREE WITH ORDER ON REQUEST

OR SEND £1.00

GEIGER COUNTER KIT. Complete with tube, PCB and all components to build a battery operated geiger counter. £39.00 ref 39P1R

FM BUG KIT. New design with PCB embedded coil. Transmits to any FM radio. 9v battery req'd. £5.00 ref 5P158R

FM BUG Built and tested superior 9v operation. £14.00 ref 14P3R

COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39R.

SINCLAIR C5 MOTORS 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22R.

As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8R.

SINCLAIR C5 WHEELS 13" or 16" dia including treaded tyre and inner tube. Wheels are black, spoked one piece poly carbonate. 13" wheel £6.00 ref 6P20R. 16" wheel £6.00 ref 6P21R.

ELECTRONIC SPEED CONTROL KIT for c5 motor. PCB and all components to build a speed controller (0-95% of speed). Uses pulse width modulation. £17.00 ref 17P3R.

SOLAR POWERED NICAD CHARGER. Charges 4 AA nicads in 8 hours. Brand new and cased £6.00 ref 6P3R.

12 VOLT BRUSHLESS FAN 1/2" square brand new ideal for boat, car, caravan etc. £5.00 ref 5P206.

ACORN DATA RECORDER ALF503 Made for BBC computer but suitable for others. Includes mains adaptor, leads and book. £15.00 ref 15P43R

VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 5 tapes New low price £8.00 ref 8P161

PHILIPS LASER. 2MW HELIUM NEON LASER TUBE. BRAND NEW FULL SPEC £40.00 REF 40P10R. MAINS POWER SUPPLY KIT £20.00 REF 20P33R READY BUILT AND TESTED LASER IN ONE CASE £75.00 REF 75P4R.

12 TO 220V INVERTER KIT as supplied it will handle up to about 15 w at 220v but with a larger transformer it will handle 80 watts. Basic kit £12.00 ref 12P17R. Larger transformer £12.00 ref 12P41R.

VERO EASI WIRE PROTOTYPING SYSTEM ideal for designing projects on etc. Complete with tools, wire and reusable board. New low bargain price only £2.00 ref B2P1

HIGH RESOLUTION 12" AMBER MONITOR 2v 1.5A Hercules compatible (TTL input) new and cased £22.00 ref 22P2R

VGA PAPER WHITE MONO monitors new and cased 240v AC. £59.00 ref 59P4R

25 WATT STEREO AMPLIFIER. STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69R (Circuit dia included).

BARGAIN NICADS AAA SIZE 200MAH 1.2V PACK OF 10 £4.00 REF 4P92R. **PACK OF 100 £30.00 REF 30P16R**

FRESNEL MAGNIFYING LENS 83 x 52mm £1.00 ref BD827R.

ALARM TRANSMITTERS. No data available but nicely made complex radio transmitters 9v operation. £4.00 each ref 4P81R.

12V 19A TRANSFORMER. Ex equipment but otherwise ok. Our price £20.00

GX4000 COMPUTERS. Customer returned games machines complete with plug in game, joysticks and power supply. Retail price is almost £100. Ours is £12.00 ref B12P1

ULTRASONIC ALARM SYSTEM. Once again in stock these units consist of a detector that plugs into a 13A socket in the area to protect. The receiver plugs into a 13A socket anywhere else on the same supply. Ideal for protecting garages, sheds etc. Complete system £25.00 ref B25P1 additional detectors £11.00 ref B11P1

IBM XT KEYBOARDS. Brand new 86 key keyboards £5.00 ref 5P612

IBM AT KEYBOARDS Brand new 86 key keyboards £15.00 ref 15P612

386 MOTHER BOARDS. Customer returned units without a cpu fitted. £22.00 ref A22P1

BSB SATELLITE SYSTEMS

BRAND NEW

REMOTE CONTROL

£49.00 REF F49P1

286 MOTHER BOARDS. Brand new but customer returns so may need attention. Complete with technical manual £20.00 ref A20P2

286 MOTHER BOARDS. Brand new and tested complete with technical manual. £49.00 ref A49P1

UNIVERSAL BATTERY CHARGER. Takes AA's, C's, D's and PP3 nicads. Holds up to 5 batteries at once. New and cased, mains operated. £6.00 ref 6P36R.

IN CAR POWER SUPPLY. Plugs into cigar socket and gives 3,4,5,6,7,9, and 12v outputs at 800mA. Complete with universal spider plug. £5.00 ref 5P167R.

RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170R.

CAPACITOR PACK 100 x 50 values (500 capacitors) all 1/4 watt 2% metal film. £5.00 ref 5P170R.

MIRACOM WS4000 MODEMS

V21/23

AT COMAND SET

AUTODIAL/AUTOANSWER

FULL SOFTWARE CONTROL

tone AND PULSE DIALLING

£29

IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186R.

COPPER CLAD STRIP BOARD 17" x 4" of .1" pitch "vero" board. £4.00 a sheet ref 4P62R or 2 sheets for £7.00 ref 7P22R.

STRIP BOARD CUTTING TOOL £2.00 ref 2P352R.

50 METRES OF MAINS CABLE £3.00 2 core black precut in convenient 2 m lengths. Ideal for repairs and projects. ref 3P91R

4 CORE SCREENED AUDIO CABLE 24 METRES £2.00 Precut into convenient 1.2 m lengths. Ref 2P365R

TWEETERS 2 1/4" DIA 8 ohm mounted on a smart metal plate for easy fixing £2.00 ref 2P368R

COMPUTER MICE Originally made for Future PC's but can be adapted for other machines. Swiss made £8.00 ref 8P57R. Atari ST conversion kit £2.00 ref 2P362R.

6 1/2" 20 WATT SPEAKER Built in tweeter 4 ohm £5.00 ref 5P205R

WINDUP SOLAR POWERED RADIO! FM/AM radio takes rechargeable batteries complete with hand charger and solar panel 14P200R

PC STYLE POWER SUPPLY Made by AZTEC 110v or 240v input. +5 @ 15A, +12 @ 5A, -12 @ 5A, -5 @ 3A. Fully cased with fan, on/off switch, IEC inlet and standard PC flyleads. £15.00 ref F15P4

ALARM PIR SENSORS Standard 12v alarm type sensor will interface to most alarm panels. £16.00 ref 16P200

ALARM PANELS 2 zone cased keypad entry, entry exit time delay

BULL ELECTRICAL
250 PORTLAND ROAD HOVE SUSSEX
BN3 5QT TELEPHONE 0273 203500

MAIL ORDER TERMS: CASH OR CHEQUE
WITH ORDER PLUS £3.00 POST PLUS VAT.

PLEASE ALLOW 7 - 10 DAYS FOR DELIVERY

NEXT DAY DELIVERY £5.00

FAX 0273 23077

SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

etc. £18.00 ref 18P200

MODEMS FOR THREE POUNDS!!

Fully cased UK modems designed for dial up system (PSTN) no data or info but only £3.00 ref 3P145R

TELEPHONE HANDSETS

Bargain pack of 10 brand new handsets with mic and speaker only £3.00 ref 3P146R

BARGAIN STRIPPERS

Computer keyboards. Loads of switches and components excellent value at £1.00 ref CD40R

DATA RECORDERS

Customer returned mains battery units built in mic ideal for Computer or general purpose audio use. Price is £24.00 ref 4P100R

SPECTRUM JOYSTICK INTERFACE

Plugs into 48K Spectrum to provide a standard Atari type joystick port. Our price £4.00 ref 4P101R

ATARI JOYSTICKS

Ok for use with the above interface, our price £4.00 ref 4P102R

BENCH POWER SUPPLIES

Superbly made fully cased (metal) giving 12v at 2A plus a 6V supply. Fused and short circuit protected. For sale at less than the cost of the case! Our price is £4.00 ref 4P103R

SPEAKER WIRE

Brand new twin core insulated cable 100 feet for £2.00 REF 2P79R

MAINS FANS

Brand new 5" x 3" complete with mounting plate quite powerful and quite. Our price £1.00 ref CD41R

DISC DRIVES

Customer returned units mixed capacities (up to 1.44M) We have not sorted these so you just get the next one on the shelf. Price is only £7.00 ref 7P11R (worth it even as a stripper)

HEX KEYBOARDS

Brand new units approx 5" x 3" only £1.00 each ref CD42R

PROJECT BOX

51/2" x 31/2" x 1" black ABS with screw on lid. £1.00 ref CD43R

SCART TO SCART LEADS

Bargain price leads at 2 for £3.00 ref 3P147R

SCART TO D TYPE LEADS

Standard Scart on one end, Hi density D type on the other. Pack of ten leads only £7.00 ref 7P2R

OZONE FRIENDLY LATEX

250ml bottle of liquid rubber sets in 2 hours. Ideal for mounting PCB's fixing wires etc. £2.00 each ref 2P379R

QUICK SHOTS

Standard Atari compatible hand controller (same as joysticks) our price is 2 for £2.00 ref 2P380R

VIEWDATA SYSTEMS

Cased units made by TANDATA complete with 1200/75 built in modem infra red remote controlled qwerty keyboard BT approved Prestel compatible, Centronics printer port RGB colour and composite output (works with ordinary television) complete with power supply and fully cased. Our price is only £20.00 ref 20P1R

AC STEPDOWN CONVERTOR

Cased units that convert 240v to 110v 3" x 2" with mains input lead and 2 pin American output socket (suitable for resistive loads only) our price £2.00 ref 2P381R

SPECTRUM +2 LIGHT GUN PACK

complete with software and instructions £8.00 ref 8P58R/2

CURLY CABLE

Extends from 8" to 6 feet! D connector on one end, spade connectors on the other ideal for joysticks etc (6 core) £1.00 each ref CD44R

COMPUTER JOYSTICK BARGAIN

Pack of 2 joysticks only £2.00 ref 2P382R

BUGGING TAPE RECORDER

Small hand held cassette recorders that only operate when there is sound then turn off 6 seconds after so you could leave it in a room all day and just record any thing that was said. Price is £20.00 ref 20P3R

IEC MAINS LEADS

Complete with 13A plug our price is only £3.00 for TWO! ref 3P148R

NEW SOLAR ENERGY KIT

Contains 8 solar cells, motor, tools, fan etc plus educational booklet. Ideal for the budding enthusiast! Price is £12.00 ref 12P2R

286 AT PC

286 MOTHER BOARD WITH 640K RAM FULL SIZE METAL CASE, TECHNICAL MANUAL, KEYBOARD AND POWER SUPPLY £139 REF 139P1 (no i/o cards or drives included) Some metal work req'd phone for details.

35MM CAMERAS

Customer returned units with built in flash and 28mm lens 2 for £8.00 ref 8P200

STEAM ENGINE

Standard Mamod 1332 engine complete with boiler piston etc £30 ref 30P200

TALKING CLOCK

LCD display, alarm, battery operated. Clock will announce the time at the push of a button and when the alarm is due. The alarm is switchable from voice to a cack crowling £14.00 ref 14P200R

HANDHELD TONE DIALERS

Small units that are designed to hold over the mouth piece of a telephone to send MF dialling tones. Ideal for the remote control of answer machines. £5.00 ref 5P209R

COMMODORE 64 MICRODRIVE SYSTEM

Complete cased brand new drives with cartridge and software 10 times faster than tape machines works with any Commodore 64 setup. The original price for these was £49.00 but we can offer them to you at only £25.00! REF 25P1R

ATARI 2600 GAMES COMPUTER Brand new with joystick and 32 game cartridge (plugs into TV) £29.00 ref F29P1 also some with 1 game at £19.00 ref F19P2.

BEER PUMPS Mains operated with fluid detector and electronic timer standard connections. Ex equipment. £18.00 ref F18P1

90 WATT MAINS MOTORS Ex equipment but ok (as fitted to above pump) Good general purpose unit £9.00 ref F9P1

HI FI SPEAKER BARGAIN Originally made for TV sets they consist of a 4" 10 watt 4R speaker and a 2" 140R tweeter. If you want two of each plus 2 of our crossovers you can have the lot for £5.00 ref F5P2.

VIDEO TAPES E180 FIFTY TAPES FOR £70.00 REF F70P1

360K 5 1/4" Brand new drives white front. £20.00 Ref F20P1

IN SUSSEX? CALL IN AND SEE US!

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

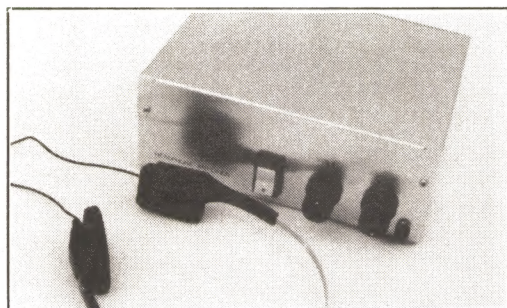
ABC
CONSUMER PRESS

VOL. 21 No. 7 JULY 1992

The No. 1 Independent Magazine for Electronics,
Technology and Computer Projects

ISSN 0262 3617

PROJECTS... THEORY... NEWS...
COMMENT... POPULAR FEATURES...



Projects

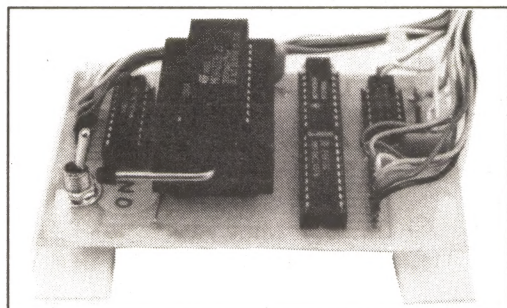
CLASS-A HEADPHONE AMPLIFIER by P. Henderson 412
Get the very best quality from your CD player or tuner and headphones

QUICK PROM by John Becker 418
Speed up the development time of microcontroller systems

UV EXPOSURE TIMER by Alan Winstanley 437
Get the production of p.c.b.s under control with this unit

CRICKET GAME by Steve Knight 443
An electronic simulation of the real thing – without the interference of rain

GARDEN HOSEPIPE CONTROLLER 452
by T. R. de Vaux-Balbirnie
Automatic watering for your garden



Series

CIRCUIT SURGERY by Mike Tooley 422
Our clinic for constructors – your problems solved

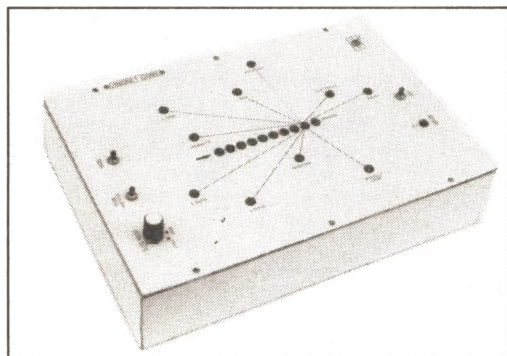
INFORMATION TECHNOLOGY AND THE NATIONAL CURRICULUM by T. R. de Vaux-Balbirnie 426
Part Nine: Logic Systems

MAKING YOUR OWN PCBs – 3 by Alan Winstanley 433
A guide to p.c.b.s and how to make your own

ACTUALLY DOING IT by Robert Penfold 450
Transformer wiring

INTERFACE by Robert Penfold 458
Bar Codes

AMATEUR RADIO by Tony Smith G4FAI 468
RSGB Open House; Services Provided; Youth In Action; Radio Bygones



Features

EDITORIAL 411

FOR YOUR ENTERTAINMENT by Barry Fox 416
Organised; Hang-On!; In The Picture; Video Phone; Photo CD

EVERYDAY NEWS 440
A window on the world of electronics

ELECTRONICS VIDEOS 442
Learn about your favourite subject with these videos

SHOPTALK with David Barrington 459
Component buying for EE projects

DOWN TO EARTH by George Hylton 461
Distortion measurement

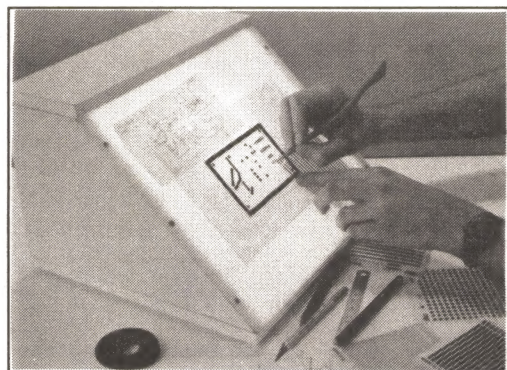
EVERYDAY READOUT 462
The best feature in the mag – its written by you! Our letters page

DIRECT BOOK SERVICE 463
Selected technical books, EE books and all Babani books by mail order

PRINTED CIRCUIT BOARD SERVICE 466
A special PCB SALE (while stocks last) – boards for EE projects

ADVERTISER'S INDEX 472

Readers Services • Editorial and Advertisement Departments 411



© Wimborne Publishing Ltd 1992. Copyright in all drawings, photographs and articles published in **EVERYDAY ELECTRONICS** is fully protected, and reproduction or imitations in whole or in part are expressly forbidden.

Our August '92 Issue will be published on Friday, 3 July 1992. See page 403 for details.

SURVEILLANCE PROFESSIONAL QUALITY KITS

No. 1 for Kits

Whether your requirement for surveillance equipment is amateur, professional or you are just fascinated by this unique area of electronics SUMA DESIGNS has a kit to fit the bill. We have been designing electronic surveillance equipment for over 12 years and you can be sure that all of our kits are very well tried, tested and proven and come complete with full instructions, circuit diagrams, assembly details and all high quality components including fibreglass PCB. Unless otherwise stated all transmitters are tuneable and can be received on an ordinary VHF FM radio.

UTX Ultra-miniature Room Transmitter

Smallest room transmitter kit in the world! Incredible 10mm x 20mm including mic. 3-12V operation. 500m range.....£16.45

MTX Micro-miniature Room Transmitter

Best-selling micro-miniature Room Transmitter
Just 17mm x 17mm including mic. 3-12V operation. 1000m range.....£13.45

STX High-performance Room Transmitter

Hi performance transmitter with a buffered output stage for greater stability and range. Measures 22mm x 22mm including mic. 6-12V operation, 1500m range.....£15.45

VT500 High-power Room Transmitter

Powerful 250mW output providing excellent range and performance. Size 20mm x 40mm. 9-12V operation. 3000m range.....£16.45

VXT Voice Activated Transmitter

Triggers only when sounds are detected. Very low standby current. Variable sensitivity and delay with LED indicator. Size 20mm x 67mm. 9V operation. 1000m range.....£19.45

HVX400 Mains Powered Room Transmitter

Connects directly to 240V AC supply for long-term monitoring. Size 30mm x 35mm. 500m range.....£19.45

SCRX Subcarrier Scrambled Room Transmitter

Scrambled output from this transmitter cannot be monitored without the SCDM decoder connected to the receiver. Size 20mm x 67mm. 9V operation. 1000m range.....£22.95

SCIX Subcarrier Telephone Transmitter

Connects to telephone line anywhere, requires no batteries. Output scrambled so requires SCDM connected to receiver. Size 32mm x 37mm. 1000m range.....£23.95

SCDM Subcarrier Decoder Unit for SCRX

Connects to receiver earphone socket and provides decoded audio output to headphones. Size 32mm x 70mm. 9-12V operation.....£22.95

ATR2 Micro Size Telephone Recording Interface

Connects between telephone line (anywhere) and cassette recorder. Switches tape automatically as phone is used. All conversations recorded. Size 16mm x 32mm. Powered from line.....£13.45

UTLX Ultra-miniature Telephone Transmitter

Smallest telephone transmitter kit available. Incredible size of 10mm x 20mm! Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. 500m range.....£15.95

TLX700 Micro-miniature Telephone Transmitter

Best-selling telephone transmitter. Being 20mm x 20mm it is easier to assemble than UTLX. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. 1000m range.....£13.45

STLX High-performance Telephone Transmitter

High performance transmitter with buffered output stage providing excellent stability and performance. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. Size 22mm x 22mm. 1500m range.....£16.45

TKX900 Signalling/Tracking Transmitter

Transmits a continuous stream of audio pulses with variable tone and rate. Ideal for signalling or tracking purposes. High power output giving range up to 3000m. Size 25mm x 63mm. 9V operation.....£22.95

CD400 Pocket Bug Detector/Locator

LED and piezo bleeper pulse slowly, rate of pulse and pitch of tone increase as you approach signal. Gain control allows pinpointing of source. Size 45mm x 54mm. 9V operation.....£30.95

CD600 Professional Bug Detector/Locator

Multicolour readout of signal strength with variable rate bleeper and variable sensitivity used to detect and locate hidden transmitters. Switch to AUDIO CONFORM mode to distinguish between localised bug transmission and normal legitimate signals such as pagers, cellular, taxis etc. Size 70mm x 100mm. 9V operation.....£50.95

QTX180 Crystal Controlled Room Transmitter

Narrow band FM transmitter for the ultimate in privacy. Operates on 180 MHz and requires the use of a scanner receiver or our QRX180 kit (see catalogue). Size 20mm x 67mm. 9V operation. 1000m range.....£40.95

QLX180 Crystal Controlled Telephone Transmitter

As per QTX180 but connects to telephone line to monitor both sides of conversations. 20mm x 67mm. 9V operation. 1000m range.....£40.95

QSX180 Line Powered Crystal Controlled Phone Transmitter

As per QLX180 but draws power requirements from line. No batteries required. Size 32mm x 37mm. Range 500m.....£35.95

QRX180 Crystal Controlled FM Receiver

For monitoring any of the 'Q' range transmitters. High sensitivity unit. All RF section supplied as a pre-built and aligned module ready to connect on board so no difficulty setting up. Output to headphones. 60mm x 75mm. 9V operation.....£60.95

A build-up service is available on all our kits if required.

UK customers please send cheques, POs or registered cash. Please add £1.50 per order for P&P. Goods despatched ASAP allowing for cheque clearance. Overseas customers send sterling bank draft and add £5.00 per order for shipment. Credit card orders welcomed on 0827 714476.

OUR LATEST CATALOGUE CONTAINING MANY MORE NEW SURVEILLANCE KITS NOW AVAILABLE. SEND TWO FIRST CLASS STAMPS OR OVERSEAS SEND TWO IRCS.

★★★ Specials ★★★

DLTX/DLRX Radio Control Switch

Remote control anything around your home or garden, outside lights, alarms, paging system etc. System consists of a small VHF transmitter with digital encoder and receiver unit with decoder and relay output, momentary or alternate, 8-way dit switches on both boards set your own unique security code. TX size 45mm x 45mm. RX size 35mm x 90mm. Both 9V operation. Range up to 200m.

Complete System (2 kits).....£50.95
Individual Transmitter DLTX.....£19.95
Individual Receiver DLRX.....£37.95

MBX-1 Hi-Fi Micro Broadcaster

Not technically a surveillance device but a great idea! Connects to the headphone output of your Hi-Fi, tape or CD and transmits Hi-Fi quality to a nearby radio. Listen to your favourite music anywhere around the house, garden, in the bath or in the garage and you don't have to put up with the DJ's choice and boring waffle. Size 27mm x 60mm. 9V operation. 250m range.....£20.95

**SUMA
DESIGNS**

DEPT. EE
THE WORKSHOPS, 95 MAIN ROAD,
BAXTERLEY, NEAR ATHERSTONE,
WARWICKSHIRE CV9 2LE

VISITORS STRICTLY BY APPOINTMENT ONLY



0827 714476

FREE

**MARCO
TRADING**

**32 PAGE
SUMMER
SALE
CATALOGUE**



ALTERNATIVE ENERGY

What is the future for Alternative Energy?

Next month we start a short series about renewable energy. In part one we shall take an overview of the topic and look in some detail at the direct use of solar power. In the following months we shall examine some particular examples of renewable energy which have the potential for large-scale exploitation in the U.K. We will also examine at first hand the technology used in the design, construction and operation of modern wind turbines used to generate electricity.

SOLAR-POWERED LIGHTING UNIT

In line with our Alternative Energy series we show you how to build a unit that will provide "free" lighting for a shed, boat or caravan. There is also a simple version of the circuit that can act as a trickle-charger for a car-type battery.

GAS ALARM

A mains or 12V powered unit that will detect the build up of fuel gas plus many other types of inflammable gas and vapour. It will also detect many types of smoke.

SUB WOOFER

Most modern hi fi speaker systems are incapable of delivering good solid bass below about 50Hz. This single speaker unit is designed to add to an existing hi fi setup to provide a dramatic improvement in bass reproduction.

EVERYDAY ELECTRONICS

AUGUST ISSUE ON SALE FRIDAY 3RD JULY 1992

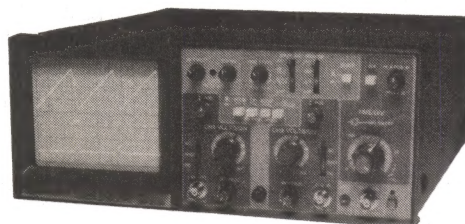
NEXT MONTH

Special Offer!

Exclusive to Everyday Electronics

SSI 2120**Dual Trace Oscilloscope**

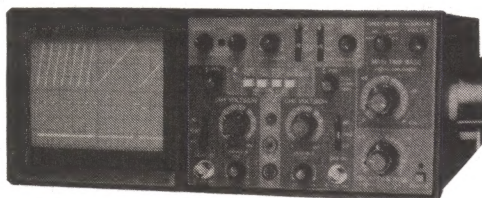
- DC - 20MHz
- 1mV sensitivity
- 0.5µS - 0.2S/div. timebase
- Versatile trigger
- TV, ALT, DC/LF
- X-Y mode



£299
(Save £61.39)

SSI 2220**Dual Trace Oscilloscope****As SSI 2120 - *PLUS***

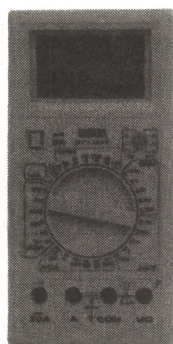
- Dual Timebase with Sweep Mode (Ideal for Pulse Waveforms)
- Component Tester



£349
(Save £70.48)

**DT 3900
DMM**

- 3 1/2 digit
- Large LCD with indicators
- Fully protected
- Diode and HFE
- Continuity

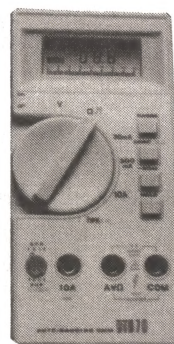


£29

(Save £12.13)

**DT870
DMM**

- Auto/manual
- 3 1/2 digit & Bargraph
- Memory features
- Continuity



£43

(Save £14.58)

Also available :

BS110 £13.50

Passive
scope
probes
(x1/x10)

TL900 £5.50

Scope test
leads

DMMs supplied with battery and test leads

Please allow 28 days for delivery

**All Prices are
Inclusive of
Post/Packing
and VAT at 17.5%**

Offer closes September 30th 1992, while stocks last.

Post this Order Form with your remittance to:

ECW INSTRUMENTS

Unit 1, Cromwell Centre, Stepfield, Witham
Essex CM8 3TH
Tel (0376) 517413 Fax (0376) 514003

Quantity	Product	Price each	Total
	SSI2120	£299.00	
	SSI2220	£349.00	
	DT3900	£29.00	
	DT870	£43.00	
	BS110	£13.50	
	TL900	£5.50	

Total price £

MARCO TRADING

INCORPORATING EAST CORNWALL COMPONENTS
ELECTRONIC COMPONENTS

& EQUIPMENT

MAIL ORDERS • WHOLESALE

RETAIL

SEND ORDERS TO - DEPT EE7

MARCO TRADING

THE MALTINGS, HIGH STREET, WEM

SHROPSHIRE SY4 5EN

Tel: (0939) 232763 Telex: 35565

Fax: (0939) 233800

ELECTRICAL & ELECTRONIC
COMPONENT SUPPLIERS

24HR ANSAPHONE

**LATEST 1992
CATALOGUE**

- ★ Velleman Kit Catalogue
- ★ Free pre-paid envelope
- ★ Many new lines
- ★ Pages of special offers
- ★ Free gifts

132 PAGES £2.00
FREE with orders over £10



**POST & PACKING
IS NOW**

£2.25

**ALL PRICES
INCLUDE**

17½% VAT

VISIT

OUR OTHER BRANCHES

SUPERTRONICS

Tel: 021 666 6504

65 HURST STREET

BIRMINGHAM B5 4TE

WALTONS

Tel: 0902 22039

55A WORCESTER ST

WOLVERHAMPTON WV2 4LL

Visit our shop in

WEM

Tel 0939 232763

JULY SPECIAL OFFER

SALE

SALE

+ KITS + KITS + KITS + KITS

After excellent response to our Spring Catalogue we are
giving another special price on all kits listed below

RESISTOR KITS

SALE PRICE

¼W pack 10 each value E12 - 10R to 1M 610 pieces.....	£5.10	£4.00
¼W pack 5 each value E12 - 10R to 1M 305 pieces.....	£3.75	£2.99
¼W pack Popular - 10R to 10M 1000 pieces.....	£6.99	£5.00
½W pack 10 each value E12 - 2R2 to 2M2 730 pieces.....	£8.75	£7.00
½W pack 5 each value E12 - 2R2 to 2M2 365 pieces.....	£5.40	£4.00
½W pack Popular - 2R2 to 10M 1000 pieces.....	£10.75	£9.00
1W pack 5 each value E12 - 2R2 to 1M 365 pieces.....	£15.25	£13.00
2W pack 5 each value E12 - 10R to 2M2 317 pieces.....	£25.00	£22.00

ADDITIONAL KITS

Disc ceramic 50V.....	125 pieces	£3.99	£3.00
Zener Diodes 5ea 400mA.....	55 pieces	£3.99	£3.00
Electrolytics caps. radial.....	100 pieces	£8.50	£7.00
Fuses Q blow 20mm.....	80 pieces	£4.75	£3.50
Fuses T delay 20mm.....	80 pieces	£8.50	£7.00
Pre-set pots. Hor.....	120 pieces	£7.75	£6.50
Pre-set pots. Vert.....	120 pieces	£7.75	£6.50
Polyester 100V.....	110 pieces	£5.00	£4.00

EACH VALUE INDIVIDUALLY PACKED

**NI-CAD RECHARGEABLE
BATTERIES**

	PRICE	EACH
AAA	1+	10+
AA	£1.50	£1.30
C	95p	85p
D	£1.95	£1.80
PP3	£2.00	£1.85
	£3.90	£3.75

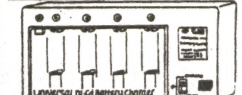
**SCART
ADAPTOR**



T113Z (2XSC)
£10.50

Scart plug to
two scart sockets
for coupling three
pieces of audio,
video equipment
with scart sockets.

NI-CAD CHARGER



Charges AA, AAA, C, D & PP3
Ni-Cads 240V AC **£4.99**

**FULL RANGE
OF BABANI
BOOKS IN OUR
CATALOGUE**

QUARTZ-HALOGEN SPOTLIGHT

THIS UNIT SUBJECT TO DESIGN CHANGE

Hand held or hanging. Heat resistant polycarbonate housing, highly polished reflector. Protective lens cover doubles as base stand. With On/Off switch and 12ft curly cable terminating in cigar lighter plug. Produces 250,000 candle power - 5 times the intensity of average car headlamps.

Price £5.75

Power.....12V d.c. 4.5A 55W
Dims.....160 x 88 x 110mm



TWIN FLUORESCENT LAMP - 12V



A very attractive twin tube lampholder with two 12V BW fluorescent tubes. White plastic case with clear plastic ribbed diffuser and ON/OFF switch. Supplied with 90cms of twin flex for connection to 12V battery (Red stripe to positive). Ideal for caravans, boats, vans, etc.
Overall dimensions: 370 x 65 x 41mm
ORDER CODE Opto TFL 12

PORTABLE FLUORESCENT LAMP - 12V



Free-standing or hanging with 15ft cable terminating in cigar lighter plug. For use in car, boat, van or home emergency. 12V dc. EVEN FLOATS IN WATER!
Overall dimensions: 430 x 30mm
ORDER CODE 1+ 10+ 50+
Price £6.50 £6.00 £5.25

ANTEX IRONS

C-15W IRON.....	£9.30	XS-KIT 25W.....	£13.45
CS-17W IRON.....	£9.15	CS-KIT 17W.....	£13.30
XS-25W IRON.....	£9.50	C-KIT 15W.....	£13.15

All bits for irons £1.95, Elements £5.30 Stands £3.75

Price £6.50 £6.00 £5.25

SINGLE FLUORESCENT LAMP - 12V

Identical to above unit but single tube. 12V dc. 8 Watts. Dims 360 x 62 x 37mm.
ORDER CODE Opto SL **£5.50**

SPARE TUBES

Replacement tube for above Twin and Single fluorescent lamps. Fits most 12V fluorescent lamps. Philips, etc. Tube length: approx 300mm (inc. pins).
ORDER CODE Opto Tube **£1.50 ea, 10 for £12**

SOLDER 18 & 22 SWG - 500gm REEL

★ 18swg	£4.95	£4.70	★
★ 22swg	£4.99	£4.75	★

Remember: Our prices INCLUDE VAT!

CLOSED CIRCUIT TELEVISION SYSTEM

1 x CAMERA	£120	1 x CAMERA BRACKET	£7.75
------------	-------------	--------------------	--------------



Complete price **£185**
Plus £10 carr

£70 USED 1 X MONITOR

FM TRANSMITTER

Made in U.K.

Very high quality 'Mini-Bug' - ideal for baby alarm, etc! A very good range is obtainable - we have obtained over ½ mile, but it does depend on conditions. Simply remove cover - insert battery - and you're ready to go. Reception can be obtained on any FM radio.
Frequency 105-108MHz FM

ORDER CODE SEC/FMB1

PRICE: £9.99

FM KIT

For those of you who enjoy building kits - we now offer the above transmitter in kit form. Ideal for the beginner - supplied complete with full, easy to follow instructions. Box NOT INCLUDED - See our BOXES Section for suitable housing.
ORDER CODE SEC/FMKIT

PRICE: £7.50

HOME ALARM PACKAGE

- Includes:
- ★ Optima Alarm Control Panel
- ★ External Red Bell Box
- ★ 2 x 1 Internal Passive I.R.
- ★ 2 x Door Contacts
- ★ Siren for bell box
- ★ 100 mtrs. cable and clips
- ★ Full fitting instructions

ONLY £130

★★ **BELL BOXES** ★★

A very attractive external box made of Polypropylene. Supplied complete with back plate. Available in Red, Yellow, Blue, White.

	BASIC	FLASHING	
SEC/RED	£8.99	SEC/RS	£9.99
SEC/YELLOW	£8.99	SEC/YS	£9.99
SEC/BLUE	£8.99	SEC/BS	£9.99
SEC/WHITE	£8.99	SEC/WS	£9.99

**BACK-UP LEAD
ACID BATTERY**

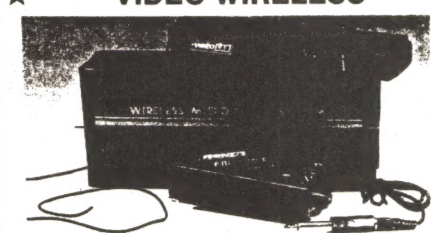
12V 1.9Ah

★ **£15.27**

★ **LEAD ACID
CHARGER**

★ **£19.99**

★ **VIDEO WIRELESS**



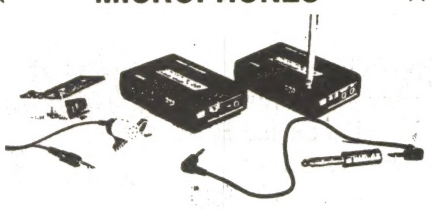
VIDEO - WIRELESS MICROPHONE - HAND HELD

A 2 part wireless mic. system designed for use with video camcorders. Microphone has HIGH/LOW power switch to select the transmission range up to 200ft. The receiver has a mounting shoe for fixing to the camcorder. Volume control & lead with 3.5mm jack plug. Complete with vinyl carrying case.

ORDER CODE MIC/G210

PRICE £45.99

★ **MICROPHONES**

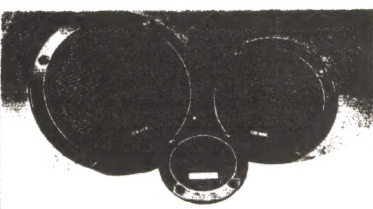


VIDEO - WIRELESS MICROPHONE - TIE CLIP

A 3 channel 2 part wireless mic. system designed for use with video camcorders. The tie clip mic. has a remote belt clip transmitter with on/off switch. The receiver has a hot shoe for mounting on the video camera. Super quality, approx 200ft range and adds great mobility to your video films!

ORDER CODE MIC/G211

PRICE £49.50



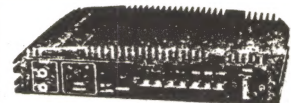
COMPONENT SPEAKER SYSTEM

B020 (TC6500) PRICE £25.75

2 x 3 way component speaker system comprising: two 6.5 woofers, two 4-mid-range, two 2.25 tweeters and all leads, filters and fixing screws. Finished in black with black mesh grills.

Maximum power.....	60W/side
Frequency response.....	60-20000Hz
Speaker sizes.....	6.5 woofer, 4 mid-range, 2.5 tweeter
Impedance.....	4Ω

**FULL RANGE OF
EMINENCE CAR
SPEAKERS AND LOUD
SPEAKERS IN STOCK**



2 x 60W CLASS A AMPLIFIER

B005LA (CPA 100)

Class A stereo in-car amplifier capable of delivering 2 x 60W stereo of 120W mono in bridge mode. Inputs are low level phono, with left and right level controls. Full thermal and overload protection.

Output power.....	2 x 60W stereo 0.1% THD
	120W mono 0.1% THD
Signal to noise ratio.....	> 80dB
Frequency response.....	20-20000Hz
Input sensitivity.....	10mV-3V adjustable
Input impedance.....	Low level input 20kΩ
Output impedance.....	4Ω
Power.....	14.4V dc 15A
Dims.....	240 x 120 x 50mm

ORDER CODE CAR/CPA100 **£41.50**

**LEAD ACID RECHARGEABLE
BATTERIES**

SEC/LA/1	12V	1.2 Amp	£14.00
SEC/LA/2	12V	1.9 Amp	£15.00
SEC/LA/3	12V	2.6 Amp	£16.00



2 x 200W CLASS A AMPLIFIER

B005M (CPA 200)

High power class A amplifier capable of delivering 2 x 200W stereo or 400W mono in bridge mode. Inputs are direct from the speaker outputs of the car radio/cassette or low level phono inputs with left and right level controls. Full thermal and overload protection.

Output power.....	2 x 200W stereo
	400W mono 0.2% THD
Signal to noise ratio.....	> 90dB
Frequency response.....	10-50000Hz
Input sensitivity.....	10mV-3V adjustable
Input impedance.....	High level input 100Ω
	Low level input 20kΩ

ORDER CODE CAR/CPA200 **£109.50**

OMNI ELECTRONICS

174 Dalkeith Road, Edinburgh EH16 5DX 031 667 2611

A COMPREHENSIVE RANGE WITH SERVICE SECOND TO NONE

OUR MUCH EXPANDED, BETTER
ILLUSTRATED CATALOGUE
COSTS £1.50 - INCLUDES
VOUCHERS TO USE
AGAINST FUTURE
PURCHASES. TO RECEIVE
A COPY PLEASE SEND
YOUR REMITTANCE
WITH THE VOUCHER BELOW.

Do
you have
your
copy
yet?

Please send me a copy of the 1990/91 OMNI catalogue.
Payment of £1.50 enclosed

NAME.....

ADDRESS.....

TELEPHONE.....

Open: Mon.-Thurs. 9.15 - 6.00

Friday 9.15 - 5.00

Saturday 9.30 - 5.00

VISA

LEDs 3mm or 5mm red or green 6p each, yellow
11p each. High intensity red, green or yellow,
5mm 30p each.
Cable ties 1p each. £5.95 per 1000. £49.50 per
10,000.
Stepping motor 4 phase 12V 7.5' step £8.95
50 ohms..... £8.95
SAA1027 stepping motor driver chip £3.95
FM Transmitter kit, good quality sound..... £8.60
High quality photo resist copper clad epoxy
glass boards
Dimensions single sided double sided
3x4 inches £0.95 £1.07
4x8 inches £2.40 £2.68
6x12 inches £5.37
12x12 inches £10.66

Rechargeable Batteries

AA (HP7) 500mAh..... £0.99
AA 700mAh..... £1.95
C 2AH with solder tags..... £3.60
D 4AH with solder tags..... £4.95
1/2AA with solder tags..... £1.55
AAA (HP16) 180mAh..... £1.75
AA 500mAh with solder tags..... £1.55
C (HP11) 1.8AH..... £2.20
D (HP2) 1.2AH..... £2.60
PP3 8.4V 110mAh..... £4.95
Sub C with solder tags..... £2.50
1/3 AA with tags (Philips CTV)..... £1.95
Standard charger, charges 4 AA cells in 5 hours
or 4Cs or 4Ds in 12-14 hours + 1xPP3 (1, 2, 3 or
4 cells may be charged at a time)..... £5.95
High power charger, as above but charges the
Cs and Ds in 5 hours; AAs, Cs and Ds must be
charged in 2s or 4s..... £10.95

Special offers - please check for availability

F cells 32dia x 87mm..... £3.95
F cell with solder tags, 1.2V..... £4.30
42mm x 16mm dia, 1.2V..... £1.45
Stick of 4 171mm x 16mm dia., with red & black
leads 4.8V..... £5.95
4 cell battery 94mm x 25mm dia.
(1/2C cells)..... £3.50
Computer grade capacitors with screw terminals,
38000µf 20V £2.50; 87000µf 10V £1.95;
68000µf 15V £2.95; 10000µf 16V £1.50
7 segment common anode led display,
12mm..... £0.45
LM2931AT 5.0 low drop out 5V
regulator TO220 package..... £0.85
7812 and 7912 12V 1A regulators..... £20.00 per 100
LM337k TO3 case variable regulator..... £1.60
100 + £1.10
BS250 P channel mosfet 45p, BC559 transistor
per 100 £3.95
74LS05 hex inverter..... £10.00 per 100
Used 8748 Microcontroller..... £3.50
SL952 UHF Limiting amplifier LC 16 surface
mounting package with data sheet..... £1.95
AM27502..... £1.25 each; 90p 100 +
CD4007UB..... 10p 100 + 9p 1000 +
TV Mains switch, 4A double pole with momentary
contacts for remote control, pack of 10 £3.95
box of 60 £19.95
DC-DC converter, Reliability model, V12P5, 12V
in 5V 200mA out, 300V input to output, isolation
with data, £4.95 each or pack of 10 - £39.50
Hour counter used 7 digit 240V ac 50Hz..... £1.45
Resistor pack 2500 resistors 1/8-2W 50 different
values..... £8.95

Resistor jumbo pack 25000, 1/4 and 1/2W
resistors our choice of values and size, will be
mainly in boxes or rolls of 1000, 2000 and 5000
of one type..... £25.00
Qwerty keyboard, 58 key good quality switches,
new..... £5.00
Qwerty keyboard with serial output, no data
(used)..... £6.00
Polyester capacitors, box type, 22.5mm lead pitch
1µf 250V dc 20p each, 15p 100 +, 10p 1000 +
2.2µf 250V dc 30p each, 20p 100 +, 15p 1000 +
3.3µf 100V dc 30p each, 15p 100 +, 10p 1000 +
1µf 50V bipolar electrolytic axial leads, 15p each,
7.5p 1000 +
0.22µf 250V polyester axial leads, 15p each,
100 + 7.5p each
Philips 123 series solid aluminium axial leads,
33µf 10V & 2.2µf 40V 40p each, 25p 100 +
Multilayer AVX ceramic capacitors, all 5mm pitch,
100V 100pf, 150pf, 220pf, 10,000pf (10n)
10p each, 5p 100 +, 3.5p 1000 +
Welwyn W23 9W 120 ohm 35p each, 20p 100 +
680 ohm 2W metal film resistor, 4p 100 +

Solid carbon resistors, very low inductance, ideal
for RF circuits, 27ohm 2W, 68ohm 2W 25p each,
15p each 100 +, we have a range of 0.25W,
0.5w, 1w and 2w solid carbon resistors - please
send SAE for list

Intelligent 4 digit alphanumeric (5x7 dot 0.145")
red LED display, 12 pin 0.8 inch wide package,
Siemens type DLE1414 £2.50 each, £2.00 50 +,
data sheets £1.00

AMD 27256-3 Eproms £2.00 each, £1.25 100 +
DIP switch 3PCO 12 pin (ERG SDC-3-023) 60p
each, 40p 100 +

MODEMS

V22/V22bis IBM PC internal full length card
modem, BT approved, can be set to com 1 or 2,
1200/2400 baud with software and manual, not
Hayes compatible, made by Plessey..... £55.00
V32 9600 baud and 4800 baud GEC Plessey
telecom external modem, model 9632, Hayes
compatible and BT approved, with auto call,
auto answer, using V25, V25bis and Hayes AT
protocols and V54 remote + local diagnostics. It
does not work on slower speeds, V22/1200 baud
etc and needs 1 internal dip switch to be
switched on to select Hayes commands. It comes
with a 100 + page comprehensive A4 size
manual. An all together brilliant machine
for only..... £199 + VAT = £233.83

All products advertised are new and
unused unless otherwise stated.

Wide range of CMOS TTL 74HC 74F Linear
Transistors kits, rechargeable batteries,
capacitors, tools etc. always in stock

Please add 95p towards P&P
VAT included in all prices

JPGELECTRONICS

276-278 Chatsworth Road
Chesterfield S40 2BH

Access/Visa Orders:
(0246) 211202

Callers welcome

PICO ADC-10

8-bit Analog to Digital Convertor

for IBM PCs & compatibles

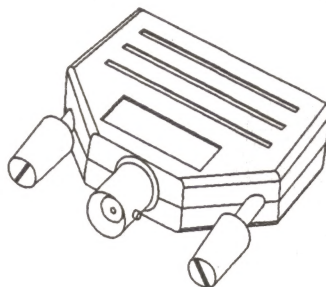
• 10-25 kHz typical sampling speed

• 0-5 v input range

£49

+ VAT

(including p+p)



- Plugs directly into parallel printer port
- Requires no external power or expansion slots
- BNC input connector
- Supplied with software to use as a voltmeter & oscilloscope, plus Turbo C and Pascal drivers

Pico Technology Limited

Broadway House, 149-151 St. Neots Road,

Hardwick, Cambridge CB3 7QJ

Tel. 0954 211716 Fax. 0954 211880

19" RACK MOUNTING EQUIPMENT CASES

This range of 19" rack cases features satin black finished 16SWG (1.5mm) steel front panels (no fixing holes visible), with the rear box assembly constructed from 20SWG (.9mm) steel. The standard units are 10" (254mm) deep. 19" project cases only 4" (101mm) deep and are available in the following popular sizes:

PROJECT CASES

Type	Height	Price
PU1	1 1/4" (44mm)	£18.02
PU2	3 1/2" (88mm)	£20.07
PU3	5 1/4" (133mm)	£22.11
PU4	7" (178mm)	£24.16
PU6	10 1/2" (266mm)	£28.25

EQUIPMENT CASES

Type	Height	Price
U1	1 1/4" (44mm)	£22.33
U2	3 1/2" (88mm)	£25.85
U3	5 1/4" (133mm)	£29.38
U4	7" (178mm)	£31.72

Delivery included (UK only).

All prices include VAT.

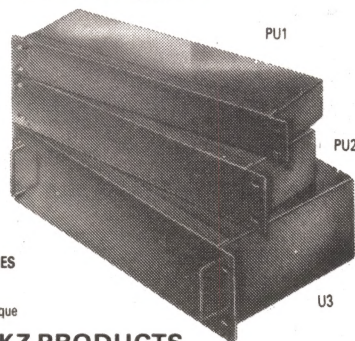
BLANKING PANELS, RACKING CONSOLES
and RACK CABINETS are also available.

Please send SAE for details.

Tel: 0272 373983 for Access/Visa Sales or cheque
with order to:

RACKZ PRODUCTS

PO Box 1402 Mangotsfield, Bristol, England, BS17 3RY



LOW COST 418MHz UHF RADIO SWITCHING

AS USED BY THE PROFESSIONAL SECURITY MARKET

Incorporating the latest Surface Acoustic Wave technology, the system consists of a small "zero-power", UHF transmitter with digital encoder and a UHF receiver unit with digital decoder and momentary output. Transmitter available either as fully assembled unit in its own key-fob case which is fully MPT approved (codes set by cutting tracks) or in kit form with 8-way DIL switch. Receiver also available in two kit forms, one which uses cut tracks to set code (over 13,000 codes available), the other uses an 8-way DIL switch (256 codes).

Kit Sizes:	Tx 45 x 30mm	Rx (both) 45 x 55mm
Kit Supplies: Tx 3-15V	Rx (both) 9-15V	Range: Up to 100m
Approved Key-fob Transmitter: TXKF.....		£25.99
Individual Kit Transmitter: TXKT.....		£15.99
Individual Kit Receiver (8-way DIL switch): RXDS.....		£19.99
Individual Kit Receiver (Cut Tracks): RXCT.....		£18.99
1 x TXKF + 1 x RXCT: SYS1.....		£39.99
1 x TXKT + 1 x RXDS: SYS2.....		£29.99

Quantity Discounts Available. Please allow 28 days for delivery

Cheques/POs to:

BLB Electronics

341 Darwen Road, Bromley Cross, Bolton BL7 9BY

HART

HART AUDIO KITS – YOUR VALUE FOR MONEY ROUTE TO ULTIMATE HI-FI

HART AUDIO KITS give you the opportunity to build the very best engineered hifi equipment there is, designed by the leaders in their field, using the best components that are available.

Every HART KIT is not just a new equipment acquisition but a valuable investment in knowledge, giving you guided hands-on experience of modern electronic techniques. In short HART is your 'friend in the trade' giving you, as a knowledgeable constructor, access to better equipment at lower prices than the man in the street. You can buy the reprints and construction manual for any kit to see how easy it is to build your own equipment the HART way. The FULL cost can be credited against your subsequent kit purchase.

Our list will give you fuller details of all our Audio Kits, components and special offers.

AUDIO DESIGN 80 WATT POWER AMPLIFIER.



This fantastic John Linsley Hood designed amplifier is the flagship of our range, and the ideal powerhouse for your ultimate hifi system. This kit is your way to get CK performance for a few tenths of the cost! Featured on the front cover of 'Electronics Today International' this complete stereo power amplifier offers World Class performance allied to the famous HART quality and ease of construction. John Linsley Hood's comments on seeing a complete unit were enthusiastic:- The external view is that of a thoroughly professional piece of audio gear, neat elegant and functional. This impression is greatly reinforced by the internal appearance, which is redolent of quality, both in components and in layout. Options include a stereo LED power meter and a versatile passive front end giving switched inputs using ALPS precision, low-noise volume and balance controls. A new relay switched front end option also gives a tape input and output facility so that for use with tuners, tape and CD players, or indeed any other 'flat' inputs the power amplifier may be used on its own, without the need for any external signal handling stages. 'Slave' and 'monobloc' versions without the passive input stage and power meter are also available. All versions fit within our standard 420 x 260 x 75mm case to match our 400 Series Tuner range. ALL six power supply rails are fully stabilised, and the complete power supply, using a toroidal transformer, is contained within a heavy gauge aluminium chassis/heat sink fitted with IEC mains input and output sockets. All the circuitry is on professional grade printed circuit boards with roller tinned finish and green solder resist on the component input side, the power amplifiers feature an advanced double sided layout for maximum performance. All wiring in this kit is pre-terminated, ready for instant use!

RLH11 Reprints of latest articles.....£1.80
K1100CM HART Construction Manual.....£5.50

LINSLEY HOOD 'SHUNT FEEDBACK' R.I.A.A. MOVING COIL & MOVING MAGNET PICKUP PREAMPLIFIER

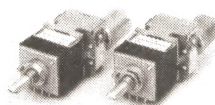


Modern, ultimate sound systems are evolving towards a built-in RIAA preamplifier within the turntable unit, keeping noise pickup to a minimum. This new circuit by John Linsley Hood uses latest generation integrated circuits in the sonically preferred shunt feedback configuration to give an accurate and musical sound, with the ability to use both moving magnet and moving coil cartridges. Power comes from two 9v PP3 size batteries or a mains power supply. This HART kit is exceptionally easy to build with detailed instructions and all the specially selected components fitting directly on to the roller tinned fibreglass printed circuit board. Even the gold plated phono sockets mount directly on the board.

This Kit now comes with latest generation low-noise front end IC and onboard power stabilisers for any DC input voltage between 9v and 30v.

K1500 Special Discount Price for complete Kit.....£67.99

ALPS PRECISION LOW-NOISE STEREO POTS.



To fulfil the need for higher quality controls we are now importing an exciting new range of precision audio pots in values to cover most quality amplifier applications. All in 2-gang stereo format, with 20mm long 6mm dia. steel shafts. Now you can throw out those noisy ill-matched carbon pots and replace with the real hi-fi components only used selectively in the very top flight of World class amplifiers. The improvement in track accuracy and matching really is incredible giving better tonal balance between channels and rock solid image stability. Motorised versions have 5v DC Drive motor.

2-Gang 100K Lin.....£8.67
2-Gang 10K, 50K & 100K Log.....£9.40
2-Gang 10K Special Balance.....£10.71
2-Gang 20K Log MOTORISED.....£19.20
2-Gang 10K Special Balance, MOTORISED, zero crosstalk and <10% centre loss with near Log/Antilog Tracks.....£19.98

HIGH QUALITY REPLACEMENT CASSETTE HEADS



Do you tapes lack treble? A worn head could be the problem. For top performance cassette recorder heads should be replaced every 1,500 hours. Fitting one of our high quality replacement heads could restore performance to better than new! Standard inductances and mountings make fitting easy on nearly all machines (Sony are special, see below) and our TC1 Test Cassette helps you set the azimuth spot on. As we are the actual importers you get prime parts at lower prices, compare our prices with other suppliers and see! All our heads are suitable for use with any Dolby system and are normally available ex stock. We also stock a wide range of special heads for home construction and industrial users.

HM120 Standard Mono R/P Head.....£3.51
HC15 Standard Quality Stereo R/P Head.....£2.49
HC66 High Quality Stereo R/P Head. Permalloy.....£7.98
HS16 Sendust Alloy Stereo Head.....£21.49
HC80 NEW RANGE High Beta Permalloy Stereo head. Modern space saver design for easy fitting and lower cost. Suitable for chrome metal and ferric tapes, truly a universal replacement head for everything from hi-fi decks to car players and at an incredible price too!.....£8.30
HQ551 4-Track RECORD & Play Permalloy Head for auto-reverse car players or quadraphonic recording £14.90
H524 Standard Erase Head.....£1.90
H561 Hi Field Erase Head for METAL Tapes.....£3.49
HRP373 Downstream Monitor Stereo Combination Head.....£47.90

Many other SPECIAL cassette Heads in stock, see our LIST.

REEL TO REEL HEADS

999R 2/4 Record/Play 110mH. Suits Stuart Tape Circuits.....£13.64
998E 2/4 Erase Head 1mH. Universal Mount. Suits Stuart.....£11.98

TAPE RECORDER CARE PRODUCTS

HART TC1 TEST CASSETTE Our famous triple purpose test cassette. Sets tape azimuth, VU level and tape speed.....£5.36
DEM1 Mains Powered Tape Head Demagnetizer, prevents noise on playback due to residual head magnetisation.....£4.48
DEM115 Electronic, Cassette Type, demagnetizer.....£8.91

COMPUTER CORNER

The following are a selection of our new range of VERY competitively priced, High Quality, computer systems. Due to our long experience of importing we have the necessary contacts in the Far East to buy at very advantageous prices and can pass the savings on to you. All hard disc machines ordered with DOS are fully formatted and ready to use.

HART MODEL AT-286/16WP COMPUTER

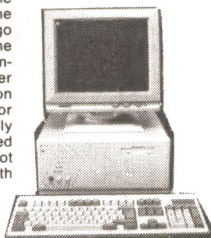
Fully fledged AT286 machine, cheap enough to use as the fastest wordprocessor in the west! Only a few years ago the AT-286 machine was the fastest standard office computer known. Now we can offer the superb 16MHz version (earlier ones were only 10 or 12MHz) at such an incredibly low price that it can be used in any office or home. Not only that but ours comes with ultrafast memory so that the machine can run in 'zero wait state'.

Advanced features are:- Full 1MB of memory (Expandable to 4MB), 102 key UK keyboard, compact desktop case, 1.2MB 5 1/4" High Density Disk Drive and interface card for extra drive, Graphics/Printer Card, built in Hard Disk Interface. HART AT-286/16WP.....ONLY £277.25
14" FST Hercules monitor, Amber.....£83
14" Paper White Hercules Monitor. (Both have T/S Base).....£86

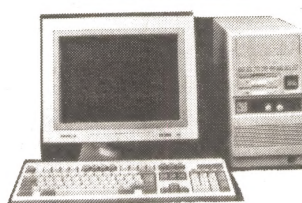
Trust Writer W/P Software uses Wordstar commands.£19.50

40MB AT-286/16UG Hard Disk Computer

Specification as above but with 45MB 25ms hard disk, VGA Colour Graphics Card with 512K RAM, parallel printer port, 2 serial ports, 1 game port.....£523.50
14" VGA Mono Monitor, Amber £86.70 Paper White £89

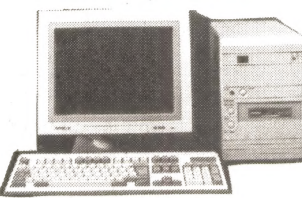


HART 40MB AT-386/16SX EL



Entry level 386 machine for demanding applications at moderate cost. Spec as our AT286/16WP with 1MB Dram memory, Mini Tower case, 45MB 25ms hard disk drive, VGA Colour Graphics Card with 256K RAM
40MB AT-386/16SX EL is.....ONLY £634.30 (Ex Vat)

HART 52MB AT-386/20SX UG



Luxury version of the above with higher processor speed and amazing 9 millisecond access time hard disk. 2MB SIMM RAM, Compact Tower Case, VGA 1024 x 768 card with 512K RAM, upgradeable to 1MB of Video memory.
40MB AT-386/20SX UG.....ONLY £853.10

OPTIONAL EXTRAS

HART Computers can be 'custom made' to fit your personal

requirements, at NO extra cost! Simply select the options you require. If replacing any item in the standard specification for that model then deduct the cost of the part not needed.

SOFTWARE

MS-DOS 5 Latest Release. Full version. 3.5" or 5.25".....£59
DR DOS 6.....£77
Microsoft Windows Latest Version 3.1.....£67

MONITORS

SM1421 AM TU Hercules Mono with FST Tube and Stand, Amber.....£83
SM1421 PW TU As Above but Paper White Screen.....£86
SM1416A VGA Mono Monitor c/w tilt and swivel stand. Amber.....£86.70
SM1416W As Above; Paper white.....£89
SM1485-00 Super VGA Multisync Colour Monitor, '28" dot pitch, 50MHz Bandwidth, up to 1024 x 768, c/w stand.....£235

KEYBOARDS

K261 102 Key Enhanced UK Layout, Tactile Click, AT/XT Switchable with dual slope feet. (Standard Keyboard supplied with systems).....£31
K108 Similar to above, single slope feet, Alps switches.....£36
KB6153A As above but with heavy metal base.....£44

I/O and GRAPHIC CARDS

AT Super I/O Card 2 x FDD, 1xIDE, 2 Serial, 1 Parallel, 1 Game Ports.....£21.20
Hercules Mono Graphic & Printer card.....£11.70
16-Bit VGA Card, 256K.....£46.50
Trident 8900 VGA Card, 512K.....£67.30
Trident 8900 VGA Card with 1Mb.....£86.90

DISK DRIVES

5.25" 1.2Mb Floppy Disk Drive.....£49
3.5" 1.44Mb Floppy Disk Drive.....£45
Adapter to fit 3.5" drive in 5.25" slot, c/w power adapter.....£9
45MB 25ms Hard Disk Drive.....£165
52MB Quantum Hard Disk. Lightning Fast 9ms Access time.....£261

CASES

WE 611P Desktop Case, Flip Top, 200W PSU.....£56.40
WE727P Mini Tower Case, 200W PSU.....£84.70
108MP Mini Tower Case, Compact Style.....£89
CT107 Midi Tower Case.....£108

MOTHERBOARDS

AT-286/16 0K RAM.....£89
AT-386-16SX 0K RAM.....£195
AT-386-20SX 0K RAM.....£245

PLEASE NOTE THAT ALL ITEMS IN THIS SECTION ARE PRICED EX VAT.

Send or 'phone for your copy of our List (50p) of these and many other Kits & Components. Enquiries from Overseas customers are equally welcome, but PLEASE send 2 IRCs if you want a list sent surface post, or 5 for Airmail.

Ordering is easy. Just write, telephone or fax your requirements to sample the friendly and efficient HART service. Payment by cheque, cash or credit card. A telephoned or faxed order with your credit card number will get your order on its way to you THAT DAY.

Please add part cost of carriage and insurance as follows:-INLAND Orders up to £20 - £1.50
Orders over £20 - £3.50 Express Courier, next working day. £10 (For safety all computer parts are only sent by courier) OVERSEAS - Please see the ordering information with our lists.



MANUFACTURERS OF QUALITY
AUDIO KITS AND COMPUTERS

24 hr. SALES LINE
(0691) 652894

AUDIO KIT PRICES are VAT
INCLUSIVE. COMPUTER
PRICES EXCLUDE VAT

HART ELECTRONIC KITS LTD
6 PENYLAN MILL
OSWESTRY, SHROPSHIRE
SY10 9AF

MAGENTA

ELECTRONICS LTD



MAIL ORDER AND

135 Hun
Burton-on-
Staffs, DE1
Tel: 0283
Fax: 0283

VERSATILE BBC INTERFACE

A comprehensive interface which allows the BBC Model B computer to be connected safely to a wide range of input and output devices. Two leads connect the interface to the User port and Printer port. Up to 16 outputs (all via single pole change-over relay contacts) and 8 inputs. All inputs are fully protected. LED indication is provided on all lines. Requires an independent 12V supply

Full Kit Ref: 844

£51.95

STEPPING MOTOR DRIVER/INTERFACE

EE Jan '92

A single board, stand alone, stepping motor driver with built-in oscillator for variable low speed, high speed, and acceleration control. Suitable for all Magenta's four-phase unipolar motors and most others - up to 35V and 1.5A per phase. Half step, Full step and Wave-drive modes - switch selectable. LED mimic display and connector for computer port.

Kit includes MD35 motor

Kit Ref: 843

Or Built

£29.95

£44.95

*Supplying Electronics
for Education,
Robotics, Music,
Computing and much,
much more*

CATALOGUE
AVAILABLE PRICE
£1.00 INC. P&P

All prices include VAT at 17.5%

Shop open 9-5 Mon.-Fri.

9-2 Saturday

Official orders welcome

Add £2

p&p to

all orders

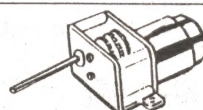
HAMEG HM 203-7 OSCILLOSCOPE

High quality reliable instrument made in W. Germany. Outstanding performance. Full two year parts and labour warranty. 20MHz-2 channels 1mV sensitivity. Easy to operate and high performance

(Cheques must be cleared) £338 + £59.15 VAT

Next day Delivery £10.00

D.C. MOTOR GEARBOXES



Ideal for Robots and Buggies. A miniature plastic reduction gearbox coupled with a 1.5-4.5 Volt mini motor. Variable gearbox reduction ratios are obtained by fitting from 1 to 6 gearwheels (supplied). Two types available:

Small Unit Type MGS £4.08

Speed range 3-2200 rpm. Size: 37 x 43 x 25mm

Large Unit Type MGL £4.65

Speed range 2-1150 rpm. Size: 57 x 43 x 29mm

STEPPING MOTORS

A range of top quality stepping motors suitable for driving a wide range of mechanisms under computer control using simple interfacing techniques.

ID36 Permanent Magnet Motor £16.86

48 steps per rev

MD200 Hybrid Motor £17.10

200 steps per rev

MD35 1/4 Permanent Magnet Motor £12.98

48 steps per rev.

MD38 Permanent Magnet Motor £9.15

48 steps per rev.

EVERYDAY ELECTRONICS KIT PROJECTS

ALL KITS HERE HAVE BEEN FEATURED IN EE AND ARE SUPPLIED WITH MAGAZINE ARTICLE REPRINTS. SEPARATE REPRINTS ALSO AVAILABLE PRICE 80p EACH INCLUSIVE P&P. KITS INCLUDE CASES, PCB'S HARDWARE AND ALL COMPONENTS (UNLESS STATED OTHERWISE) CASES ARE NOT DRILLED OR LABELS SUPPLIED UNLESS STATED.

Ref	Price	Ref	Price
844	VERSATILE BBC INTERFACE Mar 92 £51.95	700	ACTIVE I/R BURGLAR ALARM Mar 87 £40.74
843	STEPPING MOTOR DRIVER/INTERFACE Jan 92 or built £29.95 £44.95	584	SPECTRUM SPEECH SYNTH (no case) Feb 87 £23.90
842	PORTABLE ULTRASONIC PEST SCARER, Aug '91 £22.56	581	VIDEO GUARD Feb 87 £9.59
841	DIGITAL LCD THERMOSTAT May 91 with punched and printed case £29.95	569	CAR ALARM Dec 86 £14.24
840	DIGITAL COMBINATION LOCK Mar 91 with drilled case £19.86	561	LIGHT RIDER LAPEL BADGE Oct 86 £11.65
839	ANALOGIC TEST PROBE Jan 91 (no case) £13.23	560	LIGHT RIDER DISCO VERSION Oct 86 £22.41
838	MICROCONTROLLER LIGHT SEQUENCER Dec 90. With drilled and labelled case £57.17	559	LIGHT RIDER 16 LED VERSION Oct 86 £15.58
835	SUPERHET BROADCAST RECEIVER Mar 90 With drilled panels and dial £17.16	556	INFRA-RED BEAM ALARM Sep 86 £32.39
834	QUICK CAP TESTER Feb 90 £10.39	544	TILT ALARM July 86 £8.94
833	EE 4 CHANNEL LIGHT CHASER Jan 90 £32.13	542	PERSONAL RADIO June 86 £13.17
815	EE TREASURE HUNTER Aug 89 Full Kit £45.95	528	PA AMPLIFIER May 86 £30.60
814	BAT DETECTOR June 89 £21.44	523	STEREO REVERB Apr 86 £30.21
812	ULTRASONIC PET SCARER May 89 £14.81	513	BBC MIDI INTERFACE Mar 86 £31.93
800	SPECTRUM EPROM PROGRAMMER Dec 88 £30.60	497	MUSICAL DOOR BELL Jan 86 £10.07
796	SEASHELL SYNTHESISER Nov 88 £28.55	481	SOLDERING IRON CONTROLLER Oct 85 £6.25
790	EPROM ERASER Oct 88 £28.51	464	STEPPER MOTOR INTERFACE FOR THE BBC COMPUTER less case Aug 85 £9.60
769	VARIABLE 25V-2A BENCH POWER SUPPLY Feb 88 £56.82	461	CONTINUITY TESTER July 85 £7.08
744	VIDEO CONTROLLER Oct 87 £33.29	455	ELECTRONIC DOORBELL June 85 £8.63
740	ACOUSTIC PROBE Nov 87 £20.01	444	INSULATION TESTER Apr 85 £22.37
739	ACCENTED BEAT METRONOME Nov 87 £23.94	392	BBC MICRO AUDIO STORAGE SCOPE INTERFACE Nov 84 £40.82
734	AUTOMATIC PORCH LIGHT Oct 87 £19.62	387	MAINS CABLE DETECTOR Oct 84 £6.31
730	BURST-FIRE MAINS CONTROLLER Sep 87 £15.50	386	DRILL SPEED CONTROLLER Oct 84 £9.91
728	PERSONAL STEREO AMP Sep 87 £16.34	362	VARICAP AM RADIO May 84 £15.02
724	SUPER SOUND ADAPTOR Aug 87 £43.86	337	BIOLOGICAL AMPLIFIER Jan 84 £27.59
722	FERROSTAT July 87 £13.88	263	BUZZ OFF Mar 83 £6.49
719	BUCCANEER I.B. METAL DETECTOR July 87 £30.22	242	INTERCOM no case July 82 £6.50
718	3-BAND 1.6-30MHz RADIO Aug 87 £30.30	240	EGG TIMER June 82 £7.85
715	MINI DISCO LIGHTS June 87 £14.39	108	IN SITU TRANSISTOR TESTER June 78 £10.76
707	EQUALIZER (IONISER) May 87 £17.75	106	WIERD SOUND EFFECTS GEN Mar 78 £8.94
		101	ELECTRONIC DICE Mar 77 £7.15

EDUCATIONAL BOOKS & BOOK PROJECTS

ADVENTURES WITH ELECTRONICS

The classic Easy to Follow book suitable for all ages. Ideal for beginners. No soldering, uses an S-DEC breadboard. Gives clear instructions with lots of pictures. 16 projects - including three radios, siren, metronome, organ, intercom, timer, etc. Helps you learn about electronic components and how circuits work. Component pack includes an S-DEC breadboard and all the components for the series.

Adventures with Electronics £6.25

Component Pack (less book) £22.83

FUN WITH ELECTRONICS

From the USBORNE Pocket Scientist series - an enjoyable introduction to electronics. Full of very clear full colour pictures accompanied by easy to follow text. Ideal for all beginners - children and adults. Only basic tools are needed. 64 full colour pages cover all aspects - soldering - fault finding - components (identification and how they work). Also full details of how to build 6 projects - burglar alarm, radio, games, etc. Requires soldering - 4 pages clearly show you how. The components supplied in our pack allows all the projects to be built and kept. The book is available separately.

Fun with Electronics Book £2.95

Component pack (less book) £17.93

30 SOLDERLESS BREADBOARD PROJECTS

A book of projects by R. A. Penfold covering a wide range of interests. All projects are built on a Verobloc breadboard. Full layout drawings and component identification diagrams enable the projects to be built by beginners. Each circuit can be dismantled and rebuilt several times using the same components. The component pack allows all projects in the book to be built one at a time. Projects covered include amplifiers, light actuated switches, timers, metronome, touch switch, sound activated switch, moisture detector, MW Radio, Fuzz unit, etc.

30 Solderless Breadboard Projects (Book 1) £2.95

Component Pack £27.74

INSULATION TESTER

EE APRIL 85



A reliable electronic tester which checks insulation resistance of wiring appliances etc., at 500 volts. The unit is battery powered simple and safe to operate. Leakage resistance of up to 100 Megohms can be read easily. One of our own designs and extremely popular.

KIT REF 444

£22.37

3 BAND SHORT WAVE RADIO

EE AUG 87

Covers 1.6-30 MHz in 3 bands using modern miniature coils. Audio output is via a built-in loudspeaker. Advanced design gives excellent stability, sensitivity and selectivity. Simple to build.

KIT REF 718

£30.30

PORTABLE ULTRASONIC PEST SCARER

EE AUG '91

A powerful 23kHz Ultrasonic generator in a compact hand-held case. A MOSFET output drives a weatherproof transducer at up to 300V peak to peak via a special tuned transformer. Sweeping frequency output requires no setting up or alignment. Kit includes all components, PCB, transducer and case.

KIT REF 842

£22.56

EE EQUALISER

EE MAY '87

A mains powered Ioniser with an output of negative ions that give a refreshing feeling to the surrounding atmosphere. Negligible current consumption and all-insulated construction ensure that the unit is safe and economical in use. Easy to build on a simple PCB.

KIT REF 707

£17.75

LIGHT RIDERS

EE OCT '86

Three projects under one title—all simulations of the Knight Rider lights from the TV series. The three are a lapel badge using six LEDs, a larger LED unit with 16 LEDs and a mains version capable of driving six main lamps totalling over 500 watts.

KIT REF 559 CHASER LIGHT £15.58

KIT REF 560 DISCO LIGHTS £22.41

KIT REF 561 LAPEL BADGE £11.65

PET SCARER

EE MAY 89

Produces high power ultrasound pulses. L.E.D. flashes to indicate power output and level. Battery powered (9V-12V or via Mains Adaptor).

KIT REF 812

Mains Adaptor £2.02

£14.81

DIGITAL COMBINATION LOCK

EE MAR '91

Digital combination lock with a 12 key keypad. 4 digit code operates 250V-16A SPCO relay. A special anti-tamper circuit allows the relay to be mounted remotely from the keypad without any loss of security. Can be operated in many modes (latching/unlatching, manual/automatic setting, continuous/momentary output, etc.). Article describes operation as Vehicle Immobilising security system. Low current drain. Kit includes drilled case.

KIT REF 840

£19.86

ACOUSTIC PROBE

EE NOV '87

A very popular project which picks up vibrations by means of a contact probe and passes them on to a pair of headphones or an amplifier. Sounds from engines, watches and speech travelling through walls can be amplified and heard clearly. Useful for mechanics, instrument engineers and nosey parkers!

KIT REF 740

£20.01

MICROCONTROLLER LIGHT SEQUENCER

EE DEC '90

A superb kit with pre-drilled painted and silk screen printed case for a really professional finish. This kit uses a microcontroller I.C. to generate 8-channel light sequences. Sequences are selected by keypad from over 100 stored in memory. Space for 10 user programmed sequences up to 16 steps long also available. 1000 watts per channel, zero volt switching, inductive load capability. Opto-isolated for total safety. Many other features. Complete kit includes case, PCBs, all components and hardware.

KIT REF 838

£57.17

EE TREASURE HUNTER

EE AUG '89

A sensitive pulse induction Metal Detector. Picks up coins and rings etc., up to 20cms deep. Low "ground effect". Can be used with search-head underwater. Easy to use and build, kit includes search-head, handle, case, PCB and all parts as shown.

KIT REF 815

Including headphones

£45.95

DIGITAL LCD THERMOSTAT

EE MAY '91

A versatile thermostat with LCD read out. MIN/MAX temperature recording, clock and individually settable upper and lower switching points. Covers -10 to 110 degrees Celsius, accurate to within 0.1 degrees. Submersible probe on 3 meter lead. Kit includes punched and printed case. Save on energy bills by improved control of your hot water system. Also ideal for greenhouse soil temperature and aquarium control. Complete kit includes thermostat and probe, mains power supply and relay output. PCB's and punched and printed case.

KIT REF 841

£29.95

MOSFET VARIABLE BENCH 25V 2.5A POWER SUPPLY

EE FEB 88

A superb design giving 0.25V and 0-2.5A. Twin panel meters indicate Voltage and Current. Voltage is variable from zero to 25V. A Toroidal transformer MOSFET power output device, and Quad op-amp IC design give excellent performance.

KIT REF 769

£56.82

4 CHANNEL LIGHT CHASER

EE Jan '90

A 1000W per channel chaser with zero volt switching, hard drive, inductive load capability, mic sound sensor and sophisticated 'beat' detector. Chase steps to music or auto when quiet. Variable speed and mic. sens. LED mimic on front panel. Switchable for 3 or 4 channels. P552 output. Ideal for rope lights, pin spots, disco and display lighting.

KIT REF 833

£32.13

EPROM ERASER

EE OCT '88

Safe low-cost unit capable of erasing up to four EPROM's simultaneously in less than twenty minutes. Operates from a 12V supply. Safety interlock. Convenient and simple to build and use.

KIT REF 790

£28.51

SUPERHET BROADCAST RECEIVER

EE MAR '90

At last, an easy to build SUPERHET A.M. radio kit. Covers Long and medium Wave bands. built in loudspeaker with 1 watt output. Excellent sensitivity and selectivity provided by ceramic I.F. filter. Simple alignment and tuning without special equipment. Kit available less case, or with pre-cut and drilled transparent plastic panels and dial for a striking see-through effect.

KIT REF 835

£17.16



ESR ELECTRONIC COMPONENTS

Station Road, Cullercoats,
Tyne & Wear NE30 4PQ
Tel. 091 251 4363 Fax. 091 252 2296

74LS-Series	4000 Series	TRANSISTORS	LINEAR ICs	SOLDERING IRONS	RF CONNECTORS		
74LS00 £0.14	4000 £0.17	2N1613 £0.31	BC184L £0.08	BD441 £0.41	TL061 £0.35	Antex Soldering irons	BNC Solder Plug £0.85
74LS01 £0.14	4001 £0.17	2N1711 £0.26	BC186 £0.33	BD442 £0.41	TL062 £0.42	M 12 Watt £7.11	BNC Crimp Plug £0.68
74LS02 £0.14	4002 £0.17	2N1893 £0.29	BC204C £0.72	BD534 £0.47	TL064 £0.46	C 15Watt £7.11	BNC Solder Skt £1.08
74LS03 £0.14	4006 £0.32	2N2218A £0.28	BC206B £0.72	BD535 £0.48	TL071CP £0.32	G 18Watt £7.30	BNC Chassis Skt £0.78
74LS04 £0.14	4007 £0.17	2N2219A £0.25	BC207C £0.72	BD536 £0.65	TL072CP £0.34	CS 17Watt £7.21	PL259 5.2mm £0.58
74LS05 £0.14	4008 £0.31	2N2222A £0.16	BC208 £0.72	BD546 £0.52	TL074CN £0.48	XS 25Watt £7.30	PL259 11mm £0.58
74LS08 £0.14	4009 £0.19	2N2646 £0.80	BC209A £0.72	BD648 £0.52	TL081 £0.29	ST4 STAND £2.75	RND UHF socket £0.63
74LS09 £0.14	4010 £0.23	2N2904A £0.25	BC212 £0.08	BD650 £0.53	TL082CP £0.34	New PORTASOL HOBBY £11.17	SQR UHF socket £0.40
74LS10 £0.14	4011 £0.16	2N2905A £0.23	BC212L £0.08	BD707 £0.42	TL084CN £0.46	35Watt gas iron £3.00	F Plug RG58 £0.27
74LS107 £0.23	4012 £0.16	2N2907 £0.20	BC212LB £0.08	BD807 £0.80	TBA120S £0.77	DESOLDER PUMP £4.30	F Plug RG6 £0.27
74LS109 £0.21	4013 £0.17	2N2926 £0.16	BC213 £0.08	BDX32 £1.78	LM301A £0.25	ANTISTATIC PUMP £7.40	N Plug RG8 £1.64
74LS11 £0.17	4014 £0.30	2N3053 £0.27	BC213LC £0.08	BDX33C £0.46	CA311E £0.28	22SWG 0.5kg Solder £6.60	
74LS112 £0.21	4015 £0.31	2N3054 £0.90	BC214 £0.08	BDX34C £0.50	CA324 £0.23	18SWG 0.5kg Solder £0.58	
74LS113 £0.21	4016 £0.18	2N3055 £0.62	BC214L £0.08	BDX53C £0.47	LM348N £0.31		
74LS114 £0.21	4017 £0.25	2N3440 £0.50	BC237B £0.09	BDX54C £0.50	LF351N £0.36		
74LS12 £0.14	4018 £0.27	2N3702 £0.09	BC238C £0.09	BF150 £0.31	LM358N £0.27		
74LS122 £0.31	4019 £0.19	2N3703 £0.10	BC239C £0.10	BF182 £0.31	LM377 £0.27		
74LS123 £0.31	4020 £0.31	2N3704 £0.10	BC251 £0.13	BF185 £0.31	LM380N £1.12		
74LS125 £0.21	4021 £0.31	2N3705 £0.10	BC252 £0.13	BF194 £0.19	LM381 £0.27		
74LS126 £0.21	4022 £0.32	2N3706 £0.10	BC261B £0.24	BF195 £0.19	LM392N £0.79		
74LS13 £0.14	4023 £0.16	2N3771 £1.44	BC262B £0.24	BF244 £0.35	LM393N £0.28		
74LS132 £0.21	4024 £0.16	2N3772 £1.51	BC267B £0.30	BF257 £0.33	LM394 £0.98		
74LS133 £0.18	4025 £0.15	2N3773 £1.79	BC307 £0.10	BF259 £0.35	ZN414Z £1.04		
74LS136 £0.18	4026 £0.40	2N3819 £0.40	BC308 £0.10	BF337 £0.36	NE531 £1.56		
74LS138 £0.24	4027 £0.18	2N3820 £0.58	BC327 £0.10	BF355 £0.38	CA555 £0.22		
74LS139 £0.24	4028 £0.22	2N3904 £0.10	BC328 £0.10	BF423 £0.13	NE566N £0.36		
74LS14 £0.14	4029 £0.22	2N3905 £0.10	BC337 £0.10	BF451 £0.19	NE567N £0.36		
74LS145 £0.56	4030 £0.17	2N3906 £0.10	BC338 £0.10	BF459 £0.29	UA733 £0.64		
74LS147 £1.26	4031 £0.70	2N4036 £0.31	BC414C £0.13	BF469 £0.36	CA741CE £0.18		
74LS148 £0.70	4032 £0.56	2N5296 £0.57	BC441 £0.40	BF489 £0.36	CA747CE £0.39		
74LS15 £0.14	4034 £1.24	2N5321 £0.57	BC461 £0.40	BF489 £0.36	LM748CN £0.31		
74LS151 £0.25	4035 £0.31	2N6107 £0.60	BC463 £0.29	BF585 £0.31	TBA820M £0.39		
74LS153 £0.25	4040 £0.29	AC126 £0.30	BC478 £0.32	BFY50 £0.28	LM1458 £0.26		
74LS154 £0.70	4041 £0.31	AC128 £0.28	BC479 £0.32	BFY51 £0.26	ULN2004 £0.48		
74LS155 £0.25	4042 £0.22	AC187 £0.37	BC516 £0.20	BSW66 £1.35	TD2030 £1.35		
74LS156 £0.25	4044 £0.44	AC188 £0.37	BC517 £0.20	BU126 £1.32	CA3046 £0.37		
74LS157 £0.25	4046 £0.31	ACV17 £3.84	BC527 £0.20	BU205 £1.41	CA3080 £0.72		
74LS158 £0.25	4047 £0.25	AD149 £1.67	BC528 £0.20	BU208A £1.34	CA3130 £0.98		
74LS160 £0.32	4048 £0.31	AD162 £0.92	BC537 £0.20	BU326A £1.30	CA3140 £0.56		
74LS161 £0.32	4049 £0.31	AD162 £0.92	BC546C £0.08	BU500 £1.80	CA3240 £1.22		
74LS162 £0.32	4050 £0.20	BC107B £0.15	BC547C £0.09	BU508A £1.37	LM3900 £0.72		
74LS163 £0.32	4051 £0.25	BC107B £0.15	BC548C £0.08	BU526 £1.74	LM3914 £0.70		
74LS164 £0.26	4052 £0.25	BC108 £0.12	BC549C £0.10	BU806 £1.06	LM3915 £0.70		
74LS165 £0.48	4053 £0.25	BC108A £0.14	BC550C £0.08	BU806 £1.06	MC4558 £0.36		
74LS170 £0.30	4054 £0.56	BC108C £0.14	BC555A £0.08	IRF540 £1.75	NE5532 £0.80		
74LS173 £0.24	4055 £0.30	BC109C £0.15	BC556C £0.08	IRF740 £2.11	NE5534 £0.66		
74LS174 £0.24	4060 £0.31	BC114 £0.41	BC559C £0.08	MJ11015 £2.11	ICL7621 £1.70		
74LS175 £0.24	4063 £0.29	BC115 £0.41	BC560B £0.09	MJ2501 £1.60	ICM7555 £0.96		
74LS180 £0.24	4066 £0.18	BC116 £0.41	BC637 £0.21	MJ3001 £1.52	ICM7556 £0.96		
74LS191 £0.24	4067 £1.91	BC118 £0.41	BC638 £0.21	MJ3400 £0.36	ICM7557 £0.96		
74LS192 £0.24	4068 £0.16	BC132 £0.36	BC640 £0.21	MPSA13 £0.12	ICM7558 £0.96		
74LS193 £0.24	4069 £0.20	BC134 £0.36	BC640 £0.21	MPSA13 £0.12	ICM7559 £0.96		
74LS195 £0.24	4070 £0.17	BC135 £0.36	BCY70 £0.21	MPSA42 £0.17	ICM7560 £0.96		
74LS196 £0.24	4071 £0.20	BC140 £0.25	BCY71 £0.20	MR475 £0.21	ICM7561 £0.96		
74LS197 £0.24	4072 £0.17	BC141 £0.27	BCY72 £0.20	TIP121 £0.35	ICM7562 £0.96		
74LS20 £0.14	4073 £0.17	BC142 £0.31	BD135 £0.20	TIP122 £0.37	ICM7563 £0.96		
74LS21 £0.14	4074 £0.17	BC143 £0.34	BD136 £0.20	TIP125 £0.37	ICM7564 £0.96		
74LS22 £0.14	4075 £0.30	BC149 £0.12	BD137 £0.22	TIP127 £0.37	ICM7565 £0.96		
74LS221 £0.36	4077 £0.17	BC154 £0.36	BD138 £0.22	TIP132 £0.46	ICM7566 £0.96		
74LS240 £0.32	4081 £0.14	BC157 £0.12	BD139 £0.23	TIP137 £0.46	ICM7567 £0.96		
74LS241 £0.32	4082 £0.17	BC159 £0.12	BD140 £0.24	TIP142 £0.46	ICM7568 £0.96		
74LS242 £0.32	4085 £0.28	BC160 £0.28	BD150C £0.82	TIP147 £1.12	ICM7569 £0.96		
74LS243 £0.32	4086 £0.28	BC170 £0.16	BD165 £0.42	TIP295 £0.63	ICM7570 £0.96		
74LS244 £0.32	4089 £0.56	BC170B £0.16	BD166 £0.35	TIP29C £0.37	ICM7571 £0.96		
74LS245 £0.32	4093 £0.15	BC171 £0.11	BD187 £0.39	TIP305 £0.63	ICM7572 £0.96		
74LS247 £0.32	4094 £0.31	BC171B £0.16	BD201 £0.40	TIP30C £0.32	ICM7573 £0.96		
74LS251 £0.24	4095 £0.56	BC172 £0.13	BD202 £0.40	TIP31C £0.32	ICM7574 £0.96		
74LS252 £0.24	4097 £1.20	BC172B £0.13	BD203 £0.40	TIP32C £0.32	ICM7575 £0.96		
74LS258 £0.24	4098 £0.31	BC177 £0.17	BD204 £0.40	TIP33C £0.72	ICM7576 £0.96		
74LS26 £0.14	4099 £0.36	BC178 £0.17	BD222 £0.40	TIP41A £0.36	ICM7577 £0.96		
74LS266 £0.14	4502 £0.36	BC179 £0.17	BD225 £0.42	TIP42C £0.38	ICM7578 £0.96		
74LS27 £0.14	4503 £0.31	BC182 £0.08	BD232 £0.38	TIP47 £0.48	ICM7579 £0.96		
74LS271 £0.14	4508 £0.90	BC182L £0.08	BD237 £0.32	TIP48 £0.62	ICM7580 £0.96		
74LS279 £0.25	4510 £0.26	BC182LB £0.08	BD238 £0.32	TIP50 £0.53	ICM7581 £0.96		
74LS30 £0.14	4511 £0.29	BC183 £0.08	BD240B £0.37	VN10KM £0.44	ICM7582 £0.96		
74LS32 £0.14	4512 £0.31	BC183L £0.08	BD243B £0.37	VN65AF £1.50	ICM7583 £0.96		
74LS36 £0.21	4515 £0.78	BC183LB £0.08	BD244A £0.53	ZTX300 £0.16	ICM7584 £0.96		
74LS367 £0.21	4516 £0.31	BC184 £0.08	BD246 £1.06	ZTX500 £0.16	ICM7585 £0.96		
74LS368 £0.21	4518 £0.27				ICM7586 £0.96		
74LS37 £0.14	4527 £0.38				ICM7587 £0.96		
74LS373 £0.32	4520 £0.26				ICM7588 £0.96		
74LS374 £0.32	4521 £0.62				ICM7589 £0.96		
74LS375 £0.34	4526 £0.40				ICM7590 £0.96		
74LS377 £0.32	4527 £0.38				ICM7591 £0.96		
74LS378 £0.62	4529 £0.44				ICM7592 £0.96		
74LS38 £0.14	4532 £0.31				ICM7593 £0.96		
74LS390 £0.25	4534 £2.24				ICM7594 £0.96		
74LS393 £0.25	4536 £1.00				ICM7595 £0.96		
74LS396 £0.26	4538 £0.37				ICM7596 £0.96		
74LS399 £0.62	4541 £0.31				ICM7597 £0.96		
74LS40 £0.14	4543 £0.46				ICM7598 £0.96		
74LS42 £0.25	4555 £0.34				ICM7599 £0.96		
74LS47 £0.42	4556 £0.34				ICM7600 £0.96		
74LS51 £0.14	4560 £1.18				ICM7601 £0.96		
74LS5670 £0.69	4566 £1.96				ICM7602 £0.96		
74LS57 £0.17	4572 £0.25				ICM7603 £0.96		
74LS74 £0.19	4584 £0.24				ICM7604 £0.96		
74LS75 £0.19	4585 £0.32				ICM7605 £0.96		
74LS76 £0.25	4724 £0.70				ICM7606 £0.96		
74LS83 £0.31	40106 £0.24				ICM7607 £0.96		
74LS85 £0.35	40109 £0.60				ICM7608 £0.96		
74LS86 £0.20	40163 £0.46				ICM7609 £0.96		
74LS90 £0.23	40174 £0.34				ICM7610 £0.96		
74LS92 £0.35	40175 £0.36				ICM7611 £0.96		
74LS93 £0.25	40193 £0.60				ICM7612 £0.96		
74LS93 £0.25	40193 £0.60				ICM7613 £0.96		

ENAMELLED COPPER WIRE	OPTO DEVICES	VOLTAGE REGULATORS	HARDWARE	ELECTROLYTIC RADIAL CAPACITORS	ELECTROLYTIC AXIAL CAPACITORS
All 2oz Reels	5mm Red LED £0.09	78L05 £0.24	T2 Box 75 x 56 x 25mm £0.76	16V 25V 63V 100V 450V	0.47 1.0 2.2 4.7 10 22 47 100 220 470 1000 2200 4700
14 SWG £0.63	5mm Green LED £0.10	78L12 £0.24	T3 Box 75 x 51 x 25mm £0.72		
16 SWG £0.67	5mm Yellow LED £0.10	78L15 £0.24	T4 Box 111 x 57 x 22mm £0.92		
18 SWG £0.67	5mm Orange LED £0.10	78L15 £0.24	MB1 Box 79 x 61 x 40mm £1.36		
20 SWG £0.72	3mm Red LED £0.08	78L15 £0.24	MB2 Box 100 x 76 x 41mm £1.48		
22 SWG £0.76	3mm Yellow LED £0.08	78L15 £0.24	MB3 Box 118 x 98 x 45mm £1.72		
24 SWG £0.80	3mm Orange LED £0.08	78L15 £0.24	MB5 Box 150 x 100 x 60mm £2.36		
26 SWG £0.89	5mm Flashing Red £0.10	78L15 £0.24			
28 SWG £0.91	5mm Flashing Green £0.10	78L15 £0.24			
30 SWG £0.93	5mm Bi Colour £0.10	78L15 £0.24			
32 SWG £0.93	5mm Tri Colour £0.10	78L15 £0.24			
34 SWG £0.99	5mm Plastic Bezel £0.10	78L15 £0.24			
36 SWG £1.00	0.3" 7 Segment Display Red common anode £1.14	78L15 £0.24			
38 SWG £1.10	0.3" 7 Segment Display Red common cathode £1.14	78L15 £0.24			
40 SWG £1.22		78L15 £0.24			

VELLEMAN KITS	TEST & MEASUREMENT	DIODES
Stockists of the full range of Velleman kits. Catalogue available upon request.	HM103S ANALOGUE METER £11.47	Zener Diodes 2V7-33V £0.08
	HC2020S ANALOGUE METER £14.73	BZY88400Mw £0.14
	HYT07 LOGIC PROBE £18.45	BZY885 1.3W £0.06
		1N4001 £0.07
		1N4002 £0.07
		1N4003 £0.07
		1N4004 £0.07
		1N4005 £0.07
		1N4006 £0.07
		1N4007 £0.07
		1N4008 £0.07
		1N4009 £0.07
		1N4010 £0.07
		1N4011 £0.07
		1N4012 £0.07
		1N4013 £0.07
		1N4014 £0.07
		1N4015 £0.07
		1N4016 £0.07
		1N4017 £0.07
		1N4018 £0.07
		1N4019 £0.07
		1N4020 £0.07
		1N4021 £0.07
		1N4022 £0.07
		1N4023 £0.07
		1N4024 £0.07

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

VOL. 21 No. 7

JULY '92

THE MODERN AMATEUR ELECTRONICS MANUAL

I am sure a large number of our readers will have been aware of the advertising and inserts for *The Modern Amateur Electronics Manual*, previously available from WEKA Publishing, and advertised extensively in a wide range of hobbyist and technical media. The title has been widely purchased by hobbyists, student, trainees, colleges, training departments and a very wide range of retail and industrial organisations over the past four years.

Earlier this year WEKA decided to close down its UK publishing operation and a number of titles, appealing to a broad spectrum of business and hobby readers, were put up for sale. I am pleased to tell you that Wimborne Publishing – the publishers of *Everyday Electronics* – have purchased *The Modern Amateur Electronics Manual* and will continue to market this product and produce bi-monthly updates for it in the way that WEKA previously did.

PARTNER

We see this new “sister” to EE as an excellent addition to the range of publications we produce for those interested in learning about various aspects of technology. It complements EE in many ways and builds into a living encyclopaedia of electronics which keeps up with the ever advancing world of technology through regular updates/supplements.

The same editorial team will continue to produce the updates/supplements and we will endeavour to keep up the high standard WEKA have achieved and add a few new ideas of our own. One change that we have already started to introduce is to shorten the title of the publication to *The Modern Electronics Manual*. While the manual is undoubtedly of great benefit to hobbyists it has also established a very firm base in education, training and in the general electronics industry, we therefore feel the word *Amateur* in the title is inappropriate and will in future drop it.

If you are receiving the manual and updates you will have already heard from us, if not why not investigate this excellent product. You will find an advertisement for the manual on pages 456 and 457.

Mike Kenward

SUBSCRIPTIONS

Annual subscriptions for delivery direct to any address in the UK: £18.50. Overseas: £23 (£40.50 airmail). Cheques or bank drafts (in £ sterling only) payable to Everyday Electronics and sent to EE Subscriptions Dept., 6 Church Street, Wimborne, Dorset BH21 1JH. Tel: 0202 881749. Subscriptions start with the next

available issue. We accept Access (MasterCard) or Visa payments, minimum credit card order £5.

BACK ISSUES

Certain back issues of EVERYDAY ELECTRONICS are available price £1.80 (£2.30 overseas surface mail) inclusive of postage and packing per copy – £ sterling only please. Visa and Access (MasterCard) accepted, minimum credit card order £5. Enquiries with remittance, made payable to Everyday Electronics, should be sent to Post Sales Department, Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH Tel: 0202 881749. In the event of non-availability one article can be photostatted for the same price. *Normally sent within seven days but please allow 28 days for delivery. We have sold out of Jan, Feb, Mar, Apr, June, Oct, & Dec. 88, Mar & May 89 & Mar 90.*

BINDERS

Binders to hold one volume (12 issues) are available from the above address for £5.95 (£6.95 to European countries and £8.00 to other countries, surface mail) inclusive of post and packing. *Normally sent within seven days but please allow 28 days for delivery.*

Payment in £ sterling only please. Visa and Access (MasterCard) accepted, minimum credit card order £5. Tel: 0202 881749

Editorial Offices:

EVERYDAY ELECTRONICS EDITORIAL,
6 CHURCH STREET, WIMBORNE,
DORSET BH21 1JH
Phone: Wimborne (0202) 881749
Fax: (0202) 841692. DX: Wimborne 45314.

See notes on Readers' Enquiries below – we regret that lengthy technical enquiries cannot be answered over the telephone.

Advertisement Offices:

EVERYDAY ELECTRONICS ADVERTISEMENTS,
HOLLAND WOOD HOUSE, CHURCH LANE,
GREAT HOLLAND, ESSEX CO13 0JS.
Phone/Fax: (0255) 850596

Editor: MIKE KENWARD

Secretary: PAMELA BROWN

Deputy Editor: DAVID BARRINGTON

Business Manager: DAVID J. LEAVER

Editorial: WIMBORNE (0202) 881749

Advertisement Manager:

PETER J. MEW, Frinton (0255) 850596

Classified Advertisements:

Wimborne (0202) 881749

READERS' ENQUIRIES

We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply must be accompanied by a **stamped self-addressed envelope** or a **self addressed envelope and international reply coupons**.

All reasonable precautions are taken to ensure that the advice and data given to readers is reliable. We cannot however guarantee it and we cannot accept legal responsibility for it.

COMPONENT SUPPLIES

We do not supply electronic components or kits for building the projects featured, these can be supplied by advertisers.

We advise readers to check that all parts are still available before commencing any project in a back-dated issue.

We regret that **we cannot provide data or answer queries on projects that are more than five years old.**

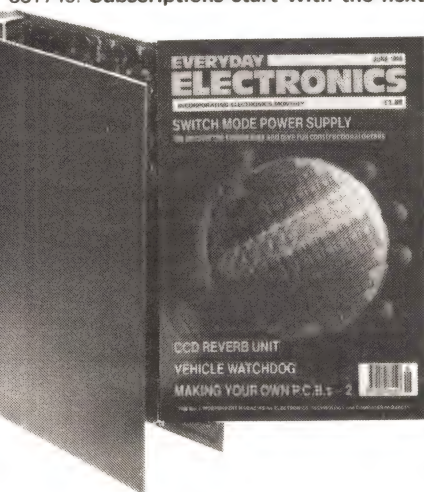
ADVERTISEMENTS

Although the proprietors and staff of EVERYDAY ELECTRONICS take reasonable precautions to protect the interests of readers by ensuring as far as practicable that advertisements are *bona fide*, the magazine and its Publishers cannot give any undertakings in respect of statements or claims made by advertisers, whether these advertisements are printed as part of the magazine, or are in the form of inserts.

The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture. Legal remedies are available in respect of some of these circumstances, and readers who have complaints should first address them to the advertiser.

TRANSMITTERS/BUGS/TELEPHONE EQUIPMENT

We would like to advise readers that certain items of radio transmitting and telephone equipment which may be advertised in our pages cannot be legally used in the U.K. Readers should check the law before using any transmitting or telephone equipment as a fine, confiscation of equipment and/or imprisonment can result from illegal use. The laws vary from country to country; overseas readers should check local laws.



CLASS-A HEADPHONE AMPLIFIER

PAUL HENDERSON

Get the very best results from your hi-fi when using headphones with this inexpensive class-A amplifier

ANY AUDIOPHILE knows the frustration of wanting to enjoy his/her favourite music when the rest of the household is intent on watching the "box". Or alternatively someone is asleep and cannot be disturbed.

In these circumstances the project described here comes into its own. Although simple, the circuit is capable of giving far higher fidelity than many standard power amplifiers on the market and substantially better than would be obtained from the headphone socket of a standard power amp. Used with a CD player and/or tuner and tape deck a very high quality system can be assembled at reasonably low cost.

DESIGN CONCEPT

Before describing the circuit in detail it will be as well to review the basic design concepts and explain just how this level of performance can be obtained. Most standard stereo power amplifiers operate in class-B.

What this means is that the output stage consists of two halves. One half handles negative going output signals whilst the other handles positive. Using this method the idling current can be limited to very low values whilst maintaining the large volt-

age and current swings required to drive a loudspeaker.

Unfortunately, these amps suffer from a form of distortion known as "crossover distortion" which occurs at and near the zero crossings of the output signal. Crossover distortion is actually due to the fact that the two halves of the circuit are not perfectly matched. The distortion generated is worst at the kind of levels needed for headphone listening.

Another problem associated with headphone sockets on main amplifiers is that a series resistance is inserted between the phones and the output stage to reduce signal levels. This is not as innocuous as it first sounds.

Speakers and headphones are designed to work from a zero impedance source. Feeding either through a series resistance results in a loss of control on the moving diaphragm by the amplifier, usually resulting in a peak in the bass response with a rapid "roll-off" below the frequency of the peak.

To produce an amplifier to drive headphones successfully and to obtain the maximum performance which they are capable of requires that both these problems must be addressed.

To design any piece of audio equipment successfully the first stage is to define exactly what it is that you require and determine the circuit from this information. A decade ago most stereo headphones were 8 ohm units, now most quality units employ Mylar film diaphragms and are usually rated 32 ohm impedance.

Visiting several hi-fi shops, most units, including the 8 ohm types have a sensitivity of between 87db and 96db/mW. Almost universally the maximum power input is limited to 100mW/channel. Of the ten pairs of headphones tested with this amplifier most were delivering truly deafening levels with 10mW input.

CLASS-A

Along with output power the amplifier also requires the usual low distortion levels, low noise and wide frequency response expected for a piece of hi-fi gear. To avoid crossover distortion the output stage must be operated in class-A.

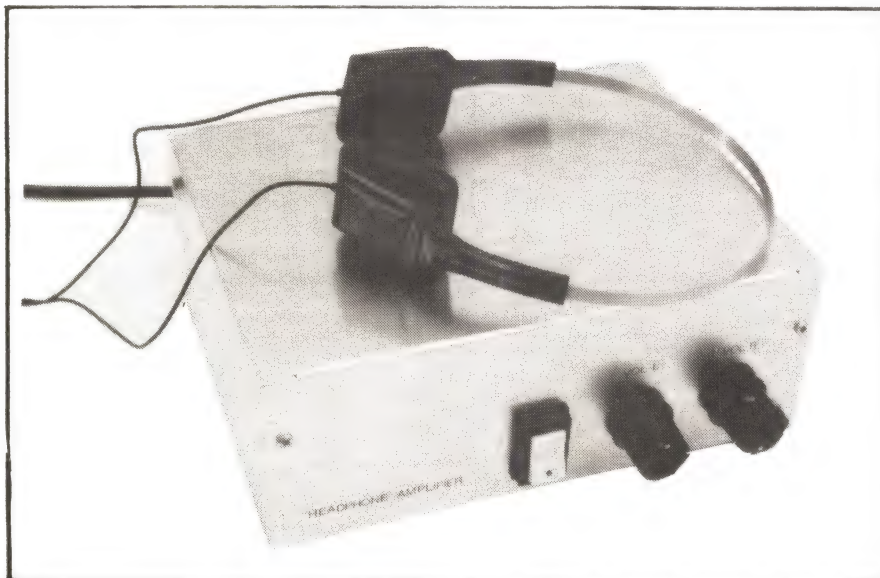
To understand what this means consider the normal small signal class-A transistor stage. To ensure maximum signal swing the collector will be biased at half the available line voltage. The current consumption of the stage will be fixed by the load resistance to which the collector is connected. In a power amplifier the load would normally be a 8 ohm loudspeaker.

Although the maths is beyond the scope of this article it can be shown that the output stage would need to consume twice as much power as delivered to the load. Hence a 50W class-A amp would need to dissipate 100W continuously to operate properly. As you may well imagine this would mean huge heatsinks and power transformers. Such amplifiers are made but you could buy a reasonable family car for the same price.

HEADPHONES

Going back to headphones, to provide 10mW of pure class-A into a pair of 32 ohm 'phones requires a voltage swing of 560mV r.m.s. and a current consumption of 25mA. This can easily be obtained with small signal transistors in the output stage. In fact the maximum output of the amplifier is just over 100mW and the "cans" (headphones) will begin to distort long before the amplifier does with high level inputs.

The output stage is only half the story however. We need to drive this properly. Several circuits were tried and the final choice was made in favour of an op.amp driver with its output stage biased into class-A. The Class-A Headphone Amplifier



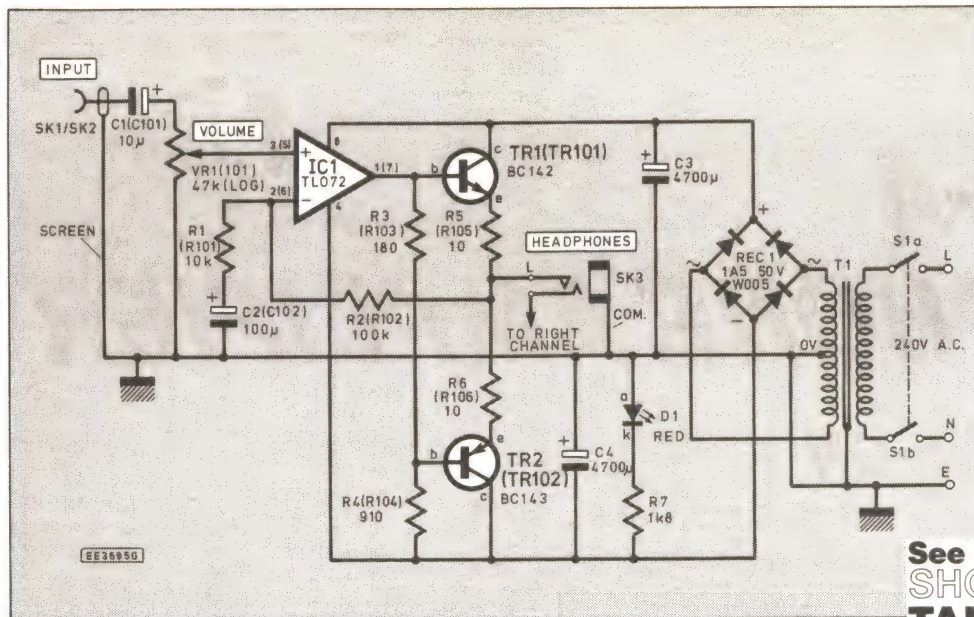


Fig. 1. Complete circuit diagram of the Class-A Headphone Amplifier.

described here has been measured for THD (total harmonic distortion) and bandwidth etc. The results were as follows:

THD: <0.005 per cent at 1kHz
Frequency Response: 2.5Hz-100kHz
-3db
Signal-to-Noise Ratio: -90db
Max. Output: 120mW/32 ohm

CIRCUIT DESCRIPTION

One channel (left) of the Class-A Headphone Amplifier and common power supply components is shown in the circuit diagram Fig. 1. Components for the right channel have one hundred added to the component numbering, i.e. R101, TR101, C102 and so on.

Essentially the amplifier is a boosted op.amp designed with both the op.amp and output stage biased into class-A. To allow direct coupling a dual rail power supply is used.

Starting from the beginning. Input signals are first coupled to the volume control VR1 via the d.c. blocking capacitor C1. This latter component has a relatively large value and sets the -3db point in the bass region. The use of the value specified sets this at 2Hz.

For most sources the capacitor could probably be removed as any reasonable signal will not have any d.c. impressed upon it. However, it's certainly better to be safe than sorry especially as one of the symptoms of a d.c. offset at the input would be a similar offset at the output.

At best this will increase current consumption in the output stage producing unwanted hum at the output. At worst the headphones could be damaged.

The volume control VR1 also sets the input impedance of the amplifier at 47kilohms (47k). Since IC1 is a j.f.e.t. input device with an input impedance of about 10-12 megohms.

There are a large number of op-amps on the market which purport to be ideal for audio applications. Most of these have been used at one time or another but still the TL072 op.amp seems to combine the best characteristics at a reasonable price. The device is low noise, has a slew rate of 13V/ μ Sec and a high current sink/source capability.

All these features make for an excellent

package. Nevertheless these devices are rarely run under optimum operating conditions.

For example the output stage of the op.amp operates with a current of a couple of milliamps and can only work in class-AB into loads of less than 10k or so. This problem can be circumvented by using a dodge from American audiophiles who bias the output stage into class-A by the simple expedient of connecting a resistor, of appropriate value, from the output to the negative supply rail. This forces the upper transistor to source current and thus biases it into class-A.

We are using the op.amp IC1 here as a non inverting amplifier feeding the input signals from the slider (moving contact) of VR1 to the non inverting input (+). Resistors R3 and R4 perform two functions. Firstly, as just described, they force the op.amp into class-A operation and secondly they provide bias for the output stage consisting of transistors TR1 and TR2.

The complementary transistors TR1 and TR2 operate in the emitter follower mode. This provides a relatively high input impedance looking into their bases and a low output impedance at the emitters.

OUTPUT STAGE

Resistors R5 and R6 are vitally important in this design. As they are in series with the emitters of TR1 and TR2 they provide local negative feedback, linearising the operation of the output stage.

Just as importantly the voltage drop across these resistors, in conjunction with the voltage drop across resistor R3 set the output stage into class-A operation. Overall negative feedback is taken from the junction of resistors R5/R6 to IC1's inverting input (pin 2), via resistor R2.

The voltage gain of the amplifier is set by the ratio of resistor R2 to R1 at 11 times. Capacitor C2 is included to reduce the gain at d.c. to unity whilst appearing as a short circuit to a.c. signals.

The output from the amplifier is fed directly to the headphones which are returned to the 0V rail. Power indication is provided by l.e.d. D1 in series with resistor R7 which limits the l.e.d.s current to a suitable value.

Having described the amplifier circuit attention can be turned to the power supply.

COMPONENTS

Resistors

R1, R101	10k (2 off)
R2, R102	100k (2 off)
R3, R103	180 (2 off)
R4, R104	910 (2 off)
R5, R105,	
R6, R106	10 (4 off)
R7	1k8

All 0.2W 1% carbon film

Potentiometers

VR1, VR100	47k rotary carbon, log. (2 off)
------------	---------------------------------

Capacitors

C1, C101	10 μ axial elect., 16V (2 off)
C2, C102	100 μ radial elect., 25V (2 off)
C3, C4	4700 radial elect., 16V (2 off)

Semiconductors

D1	5mm Red l.e.d.
TR1, TR101	BC142 npn silicon medium power transistor (2 off)
TR2, TR102	BC143 pnp silicon medium power transistor (2 off)
IC1	TL072 dual low noise op.amp
REC1	1A 100V bridge rectifier

Miscellaneous

SK1/SK2	Dual phono socket
SK3	Stereo jack socket, with matching plug
S1	DPST mains on/off switch
T1	Mains transformer: 240V a.c. primary; 0V-6V, 0V-6V 1A secondaries

Stripboard 0.1in. matrix, size 19 strips $\times$ 34 holes; aluminium case, size 152mm $\times$ 102mm $\times$ 51mm; 8-pin d.i.l. socket; audio screened cable, single-core; mains 3-core cable; strain relief clamp; plastic knobs (2 off); connecting wire; solder tag; solder etc.

Note: Components with one hundred numbers added are for the right channel.

Approx cost guidance only **£18.50**

The mains transformer T1 has dual 6V a.c. secondaries which are connected in series to provide 12V a.c. to the bridge rectifier REC1. After rectification the raw d.c. is smoothed by the electrolytic capacitors C3 and C4. Transformer T1, of course, steps down the mains voltage which is connected to its primary winding. Finally S1 provides an on/off switching function.

CONSTRUCTION

The prototype model was built in a small aluminium case, dimensions 152mm by 102mm by 51mm. This being sufficiently large to accommodate the circuit board, mains transformer, sockets, switch and volume controls. Initially, an ABS plastic case of similar dimensions was tried. However when using this the circuit was prone to electrostatic hum pickup. The result was a low level annoying buzz in the phones.

The screening provided by the aluminium case eliminates this problem. I

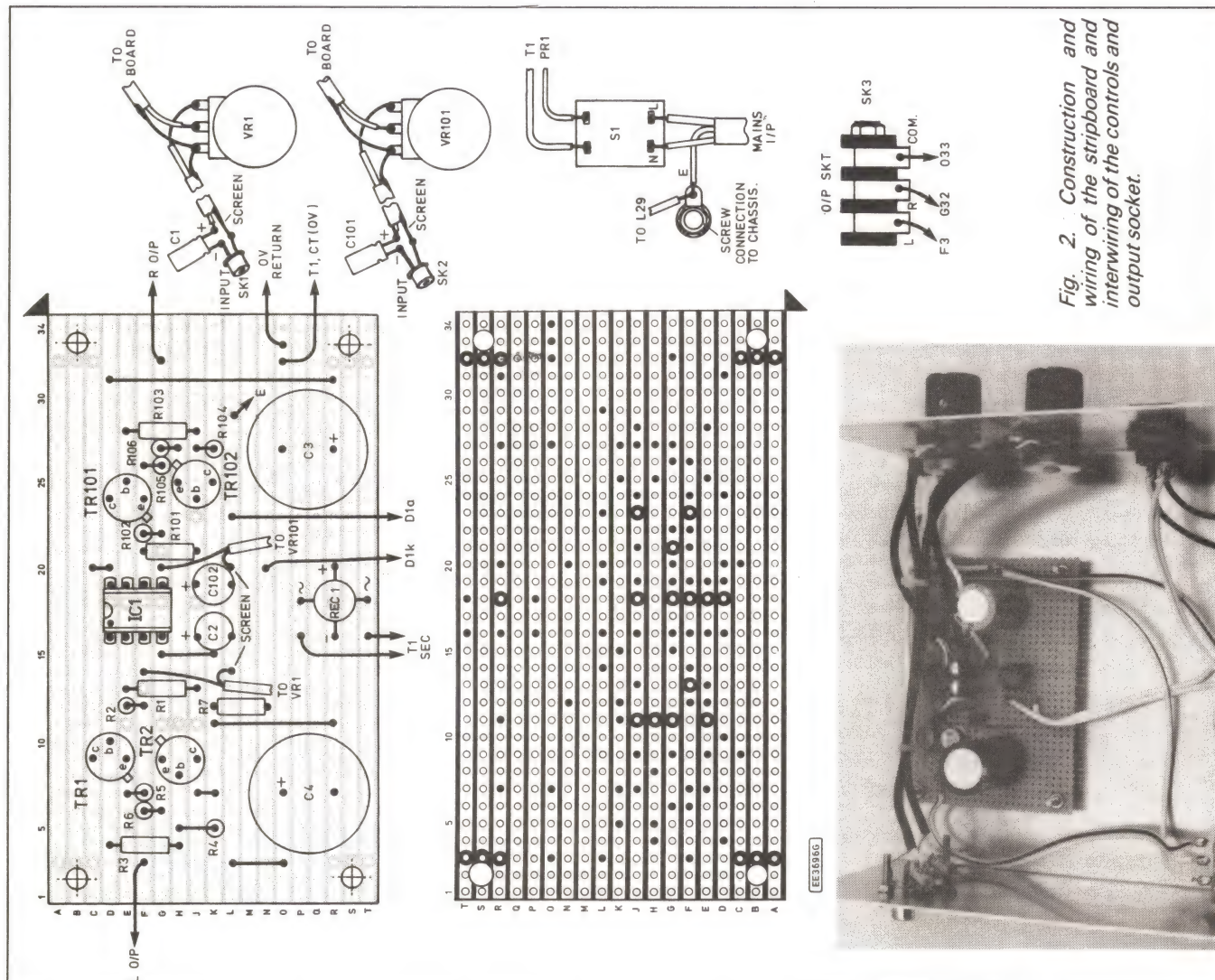


Fig. 2. Construction and wiring of the stripboard and interwiring of the controls and output socket.

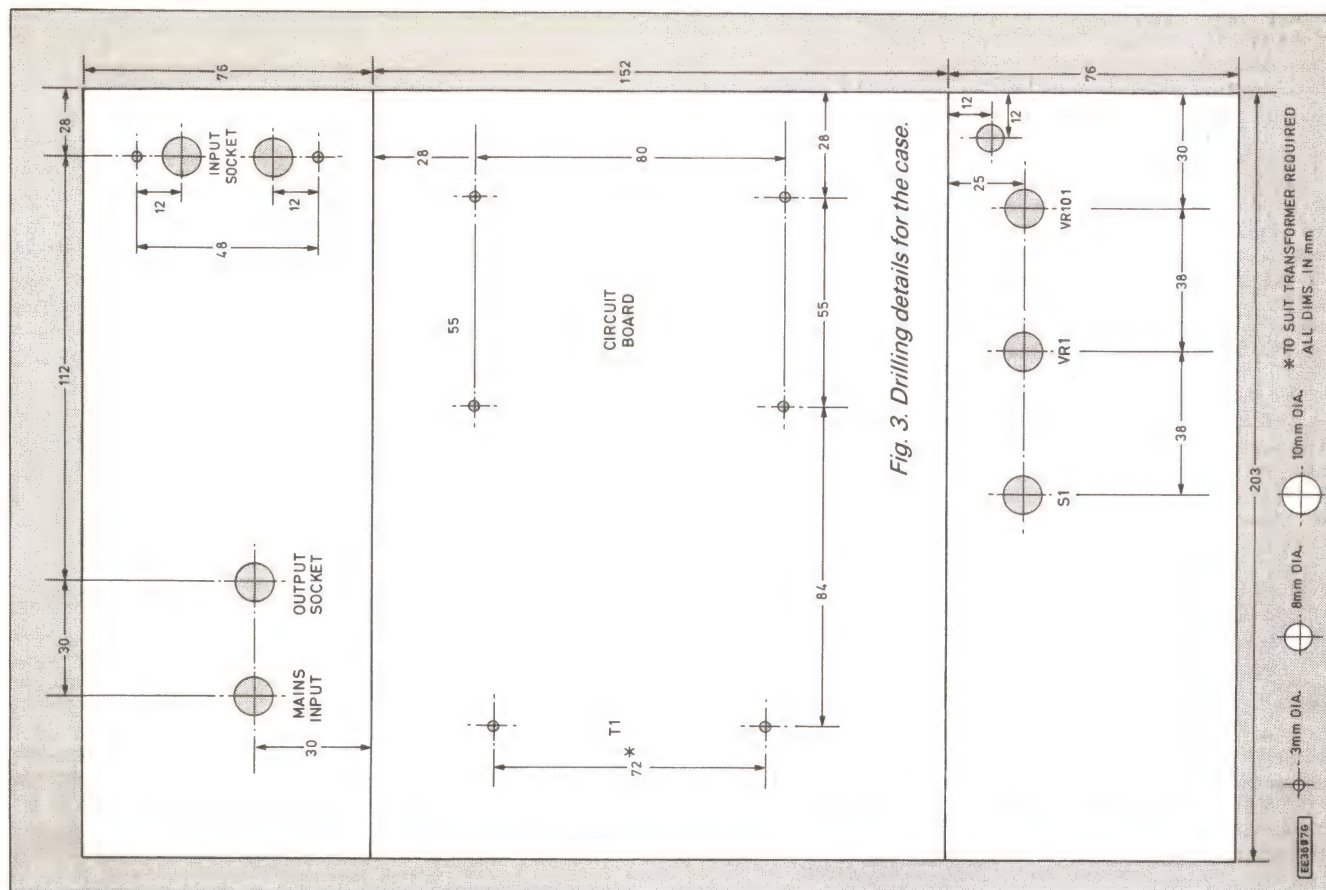


Fig. 3. Drilling details for the case.

mention this for those who might want to use the circuit in other applications. For optimum results a screened box is required with the case connected to 0V and earth.

Most of the components are mounted on a piece of 0.1in. matrix stripboard, size 19 strips by 34 holes. The component layout and details of breaks required in the underside copper tracks is shown in Fig. 2.

Commence construction of the circuit board by inserting the i.c. and use this as a reference point for the rest of the components. It is probably best to use an i.c. socket and only insert the i.c. on completion of construction and after a final wiring check.

Some people recommend soldering resistors first then capacitors and finally semi-conductors. However, it's easier if you solder the smallest parts first and work upward in size; the smaller parts are much more difficult to keep in the board prior to soldering if the board has to be balanced on larger components.

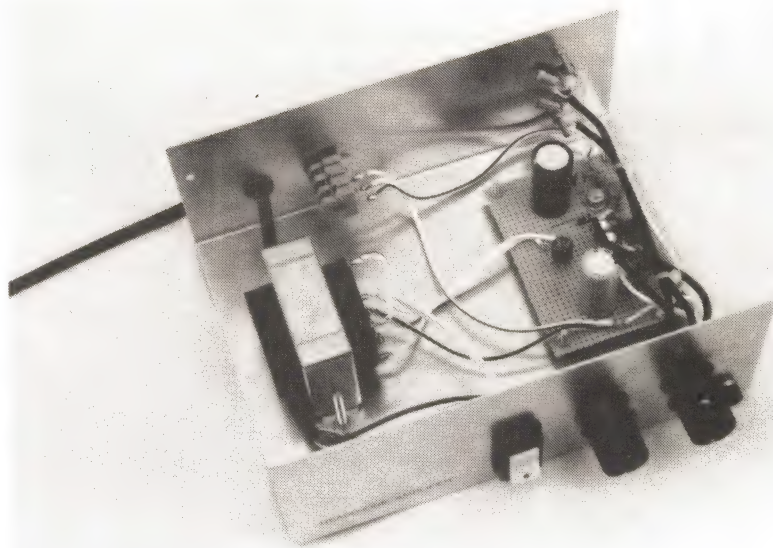
Whatever method you decide to use to wire the board remember to ensure that all polarity conscious components are correctly orientated. Failure to do so can be expensive.

When you have completed the circuit board check it to ensure that there are no dry joints or unwanted blobs of solder bridging tracks. Also check that the breaks in the tracks are made in the correct places.

Now solder the flying leads to the board in the positions shown leaving these at least 300mm long to facilitate easy interconnection. Put the board to one side and start the mechanical work.

CASE

The drilling detail for the aluminium



case is shown in Fig. 3. As you can see it's quite simple due to the fact that only the controls, input/output sockets, transformer and board mounting holes are required. The main point to note here is that the mains entry hole needs to be fitted with a 10mm cable clamping grommet.

The case can be finished to taste. The final model was sprayed matt black with car touch up paint. For a neat finish use white rubdown lettering for the legends. These can be protected by a final coat of clear varnish. Small tins of this are available from model shops. Of course, this needs to be undertaken before

the parts are attached to the case.

Final construction consists of fitting the various parts to the box and terminating the flying leads to their various destinations. Mount the board on small spacers, say 0.25in above the case. At a pinch the spacers can be substituted for four appropriately sized nuts.

Having finished the job and checked that your work is satisfactory the unit can be tested. Provided the instructions have been followed the project will now be functional.

No setting up is required. All that remains is to wish you good listening! □

EVERYDAY ELECTRONICS

Take out a years subscription to EE and you will be rewarded with the following:

- ★ Your issue on your doormat every month before it appears on the newsagents shelves (Post Office willing!)
- ★ A saving against the cover price and *no price increase* for a year
- ★ Every issue guaranteed – no need to worry if the newsagent has run out of copies
- ★ 13 issues for the price of 12, if you use the coupon below before July 31, 1992

Subscription Special Offer

OFFER ENDS JULY 31ST 1992

Offer only applicable to cheque, bank draft or PO with order or Access (Mastercard)/Visa orders – all payments must be in £'s sterling and orders must be on the coupon below, or a copy of it.

PRESENT SUBSCRIBERS If you already have a subscription to EE and want to get the special offer just extend your present sub for another year and we will give you an extra copy. Just fill in the coupon and mark **RENEWAL** in the bottom right hand box.

Post the coupon with your payment to:
Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH
Telephone 0202 881749 Fax: 0202 841692

EE SUBSCRIPTION SPECIAL OFFER

Offer ends July 31st, 1992

- ☐ Please send me 13 issues of EE for the price of 12.
- ☐ I enclose payment of £ (£18.50 UK; £23 export surface mail; £40.50 export air mail)
- ☐ Please charge my Access (Mastercard)/Visa card

Card No Ex. date Post Code

Name

Address

If you are extending a present sub print "Renewal" here

Please supply name and address of card-holder if different from the subscription address shown above. Subscriptions can only start with the next available issue. For back numbers see the Editorial page. 7/92

FOR YOUR ENTERTAINMENT

by Barry Fox



Organised

I was recently put into an awkward position.

Several years ago I wrote some pieces about the Psion Organiser, telling how I had devoted man months to trying to learn to use the tiny alpha-numeric keyboard. I got a call from the Chairman of a company, asking if I would be willing to spend some more time – on learning to use a completely new keyboard used by the then-new British system called Microwriter.

I wasn't too keen but said I would. There was then silence for a few years. When the product finally went onto the market, as the Agenda, I was sent a sample which was unusable. There was then more silence, and I was later told that the Microwriter company had been improving the Agenda system.

So I tried again, talking with Microwriter's press office. I was promised a new version Agenda, which never arrived. When I queried this I learned that Microwriter no longer employed a press officer. The job was being done by the Marketing Manager. I spoke with the MM who had never heard of me, never read anything I had written and never heard anything I've said on radio, e.g. to callers on advice line phone-ins.

I was however sent an Agenda, on loan and with the very clear proviso that if I wanted to keep it I would have to pay for it.

In the meantime several companies, including Psion, have launched similar product with Qwerty keyboards so there is less incentive for anyone to learn completely new fingering.

The proviso about having to buy to keep is perfectly reasonable. But it is also a very real disincentive to spending time on learning to microwrite and transferring large quantities of address data from my Psion 128K packs. If I worked hard and cracked the Agenda system, I would end up either having to spend a lot of money to continue, or seeing the time and work wasted.

The value to a company of an experienced press officer is being able to distinguish between journalists who are looking for free samples and those who are serious about their work. I cannot afford the time to try everything and often refuse review loans, both of hardware and software.

When I ask for something it is because I think it is worth trying but in this case the very clear proviso about needing to buy was a strong psychological deterrent to investing the time and effort

needed to learn yet another keyboard technique and language.

Microwriter now have their Agenda back. And this is all I can write about it.

Hang-On!

Do treat stories of LCD hang-on-the-wall TV screens with a pinch of salt.

Sharp is world leader in LCD technology. The size and price of Sharp's range of pocket LCD TVs confirm what a nonsense it is to predict large panel screens to hang on the wall are "just around the corner".

The largest LCD screen currently available in the UK is now Sharp's 5.6 portable TV (shown below). It costs £900. This has 170,000 pixels (each a triad of red, green and blue coloured cells). An 8.6in. monitor screen (without a TV tuner) costs around £2000 in Japan. Hitachi charges £1300 for a combined VHS playback recorder and 5in. LCD.

Can you imagine how much it would cost to extrapolate from these screen sizes to a wall-sized panel?



In The Picture

Mitsubishi's new video recorders have a feature called "Twin Intelligent Picture". The idea is to tune the record and playback parameters of the machine to the tape being used.

This approach with Intelligent HQ has already been pioneered by Akai. When a tape is put in the VCR, it automatically switches to record a test signal for a few seconds, then re-winds, replays and tweaks the recording parameters to optimize picture quality.

Akai has been reducing the test time, but Mitsubishi's TIP system drops it to

just 1.5 seconds by taking advantage of the fact that the video head drum has four heads. While two record the test signal, the other two play it back.

Video Phone

British Telecom has been demonstrating a video phone which BT says will sell for £800 a pair. These will plug into a normal telephone line socket and show one still colour picture every ten seconds. Quite why anyone should want this feature remains unexplained.

How well it works is anybody's guess, too, because BT has been showing the trade a non-working prototype, with a hole where the 3in. colour LCD should be. The only two working models were at the "Ideal Home Exhibition", and there they were working only from signals generated by a personal computer.

Photo CD

Kodak has recently demonstrated Photo CD. The quality of thermal prints available from Photo CD are good, but the price is likely to be high.

The printer handles only 11 x 8.5in. and 11 x 11in. size prints. The thermal paper materials alone cost £2.75 to the trade. Kodak's printer will not handle postcard size prints – surely a curious omission.

Users of PCs and workstations can access images from Kodak Photo CDs using any CD-ROM XA input device, or one of the new Photo CD compatible CD-ROM drives. CD-ROM XA technology was jointly developed by Microsoft, Philips and Sony as an industry standard to integrate audio and images into computing applications. Because of its compatibility with this standard, it is claimed that Photo CD can be used with virtually any type of computer adhering to common industry standards.



Kodak Photo CD system.

MAILTECH

ELECTRONIC COMPONENTS

SWITCHES - RELAYS - DIL SKTS - BOXES

PROJECT BOXES A range of high quality boxes moulded in black high impact ABS, easily drilled or punched to produce a professional looking end product

TYPE	WIDTH	LENGTH	HEIGHT	PRICE
T2	75	56	25	£0.77
T4	111	57	22	£0.92
MB1	79	61	40	£1.35
MB2	100	76	41	£1.47
MB3	118	98	45	£1.71
MB4	216	130	85	£5.19
MB5	150	100	60	£2.35
MB6	220	150	64	£3.95
MB 7	177	120	83	£3.42
MB8	150	80	50	£2.22

All sizes are in millimetres

SPECIAL OFFER - PROJECT BOX
As above boxes 50 x 70 x 25mm
60p each 10 for £5.00

KEY SWITCH
3 Position keyswitch
£2.35

MICRO SWITCH roller arm operation spdt 40p each

MINIATURE TOGGLE SWITCHES

spdt	60p each	spdt 3 position c/off	70p each
dpdt	70p each	dpdt 3 position c/off	80p each
3 pdt	90p each	spdt 3 position c/off biased both ways	70p each
4pdt	£1.20 each	dpdt 3 position c/off biased one way	80p each
spdt biased	60p each		

MINIATURE TOGGLE SWITCH pcb mounting 3pdt 50p each 10 for £4.00

DIL RELAYS 5 volt dp/changeover 60p 10 for £5.00

12 volt dp/changeover 80p 10 for £6.00

RELAY 10 amp contacts sp/changeover 12 volt coil £1.20 each

CAR HORN RELAY in metal can with fixing lug, s/pole on 10 amp contacts £1.00 each 6 for £5.00

20 AMP RELAY dp on 12 volt coil £1.50 each 4 for £5.00

REED RELAY 12 volt 50p each 10 for £4.00

DIL SKTS			'D' CONNECTORS		
8 pin	10 for	£0.60	plug	socket	cover
14 pin	10 for	£0.90	9 pin	30p	35p
16 pin	10 for	£1.00	15 pin	40p	35p
18 pin	10 for	£1.00	25 pin	50p	40p
20 pin	8 for	£1.00			
24 pin	8 for	£1.00			
28 pin	6 for	£1.00			
40 pin	5 for	£1.00			

**ALL COMPONENTS FULL
SPECIFICATION DEVICES**

SEMICONDUCTORS - TRANSISTORS - ICS - DIODES - REGULATORS - ETC

2N3702	10p ea 12 for £1.00	VOLTAGE REGS
BC337	10p ea 12 for £1.00	7812/7805/7912/7905
2N3904	10p ea 12 for £1.00	all 35p each, any 4 for £1.20
TIP31B	30p ea	AD592An Temperature Sensor i.c.
TIP 3055	90p ea	mounted on 1.5m screened lead

ALL PRICES INCLUDE VAT

BC213L	10p ea 12 for £1.00
2N3055H	60p ea
2N3771	£1.20 ea
741 op-amp	25p ea 5 for £1.00
555 timer ic	30p ea 4 for £1.00
LM324 quad	
op-amp	30p ea 4 for £1.00
1N4007 diode	20 for £1.00
1N4001 diode	25 for £1.00
1N4148 diode	40 for £1.00
BZY88C12	6p ea 10 for 50p

complete with data and application notes £1.50 ea
LM3914/LM3915 Bargraph ics £2.95 ea

Dept EE, Mailtech
PO Box 16 Ludlow
Shropshire
SY8 4NA
Tel: 058 474475

OPTO DEVICES - LEDS - DISPLAYS - COUPLERS - INDICATORS - ETC

7 SEG DISPLAY
MAN6610 2 digit 0-6" high com
anode, amber

60 p each, 4 for £2.00

OPTO-ISOLATOR OP12252

50p each 10 for £4.00

SLOTTED OPTO

£1.00 each

LEDS - LEDS - LEDS

5mm rnd red/yellow/green/amber 10p each 12 for £1.00 any mix

5mm rnd high brightness red/green 20p each 6 for £1.00 any mix

5mm rnd flashing red 60p each, yellow/green 70p each

5mm rnd bi-colour 20p each, tri-colour 30p each

Rectangular 6 x 6 x 2mm red stackable 10p each 12 for £1.00

Mounted in chrome metal bezel red/yellow/green

40p each, 3 for £1, 10 for £3.00 any mix

Mounted in a black metal bezel red only

30p each, 4 for £1.00, 10 for £2.00

**PLASTIC
BEZEL**

for 5mm
rnd leds
10 for 40p

ALARM CONTROL UNIT

Single zone alarm control unit built into a domestic light switch box. Ideal for home, caravan, boat, garage, shed etc.

Facilities: - Normally closed loop for pir sensors, door/window contacts etc.

Normally open loop for pressure mats.

24-hour loop for personal attack button

Visual indication that the system is

operational.

Automatic entry/exit delay.

Automatic system reset.

Alarm output cmos logic level.

SIREN

12 volt dc for external use
115db £8.95

BELL BOX

A plastic bell box cover
supplied with backplate.
Red/yellow/white or blue
£6.95 each

PRICE COMPLETE WITH FULL INSTRUCTIONS £8.95

BELL/SIREN INTERFACE BOARD COMPLETE £3.95

BELL/SIREN INTERFACE PCB ONLY £1.50

PASSIVE INFRA-RED ALARM SENSORS

Ex installation sensors tested working.

Type 1. Measures 180 x 112 x 70mm with walk test led, relay output

and tamper protection. 12 volt dc supply required £8.50 ea

Type 2. As above but a smaller unit 123 x 62 x 50mm £11.75 ea

DOOR/WINDOW CONTACTS

Surface or flush mounting,
white £1.10 ea

JUNCTION BOX

white 6 way 60p

Please note: There may be variations in the size of the above passive infra red sensors depending on stock at the time of ordering. But the unit will certainly be within the stated sizes.

DUAL TECH SENSOR Microwave and passive infra-red combined.

Separate led indication for each function. Measures 120 x 75 x

50mm. Relay output 12 volt dc tamper protection £29.95 ea

BREADBOARDS - CAPACITORS - SOLAR CELLS - HEATSHRINK - ETC

SOLAR CELL 2 volt 150mA max, size 60 x 100mm £1.35 ea 5 for £6

HEATSHRINK SLEEVING 8mm dia x 40mm long 5 lengths for £1.00

BNC TO BNC LEAD 2m long £2.35 **BNC TO PL259** 2m long £2.35

BNC SOCKETS 50 ohm single hole fixing 50p ea 10 for £4.00

PIEZO TRANSDUCER 5 assorted types £1.00

MERCURY TILT SWITCH

£1.00 each

PIEZO VIBRATION SENSOR

with data sheet £1.00 each

BREADBOARD

173 X 65mm 840TP £5.25 each

TEXTTOOL ZIF SOCKET

28 pin zero insertion socket £5.95 each

SOLID STATE RELAY

Switch mains up to 7 amp 12 or 5 volt

control voltage both types £2.95 ea

NI-CAD BATTERY PACK 12 volt 4aH can be split into two

6 volt packs. High temperature fast charge type £27.95

CAPACITOR 10,000 mfd 25 volt with fixing clip 60p each

CAPACITOR 470 mfd 400 volt £1.50 each 4 for £5.00

CAPACITOR Tantalum bead 10 mfd 10 volt 10 for 50p

CAPACITOR 0.1mfd 63volt 6p each 10 for 50p

EPROMS 27C256 - 25 27C512 - 25. Once programmed but never

used eprom. Mounted on a plastic carrier, can easily be removed

from the carrier or used with a low insertion force socket.

27C256 £1.00 each 6 for £5.00 **27C512** £1.20 each 5 for £5.00

Suitable low insertion force socket 28 pin 40p ea 3 for £1.00

MAILTECH

All prices include VAT.
Please add 75p carriage to all orders

QUICK PROM

JOHN BECKER

This speedy interface could save you many hours of system development time.

IT'S MOST satisfying to suddenly recognise an easier way of doing something you've been doing the hard way for ages! Such was the case regarding my addiction to designing microprocessor controlled circuits. The obvious dawned when a method of speeding the development time was spotted.

Those familiar with writing software for microprocessor controlled systems will know that a lot of development goes into the process. Much of the software debugging can initially be done on a computer. Eventually, though, the program has to be tested in-circuit.

This first requires the code to be downloaded from the computer out to a dedicated programming unit and transferred into an EPROM or EEPROM, which is then removed and placed into the module under test. Frequently, further development is required, and many improved software versions have to be repeatedly downloaded.

My own system required the use of two programs which had to be loaded independently. One controlled the code assembling and debugging operation, the other controlled the E(EP)ROM programmer. After downloading the umpteenth version of one program, loading and reloading assembling and EEPROMing software, I

chanced to query the need for using the EEPROM programmer.

All it was doing was essentially the same operation as that performed by the computer when it copied data from one location to another. Why not use a battery-backed SRAM (static random access memory) in place of the EEPROM, plugging it directly onto the computer bus and treating it as any other RAM in the system?

Having its own independent power supply built in, this type of SRAM can be removed from circuit without data being lost. It's ideal for prototyping work.

QUICK PROM

The interface circuit described here illustrates the way the technique was put into use. It was designed for use with a computer having a spare ROM (or RAM) location and for which read/write control is performed by a single line producing a 1µs write pulse. It is *not* suitable for computers which have separate read and write control lines, such as IBM-compatibles. Fig.1 and Fig.2 show the unit's block and circuit diagrams.

The computer bus directly offers the address, data and control lines required to program an SRAM. What is not allowed for, though, is the need to isolate all the chip's pins (except ground) from the computer lines before extracting it. Failure to

do so is likely to result in erroneous data being written into the chip during removal from its socket. Essentially, then, the circuit here is simply an isolator.

CIRCUIT DESCRIPTION

In the full circuit diagram, Fig.2 the SRAM is IC4, an MK48Z02 2048 × 8-bit device with built-in Lithium battery. Its eight data input/output lines are buffered

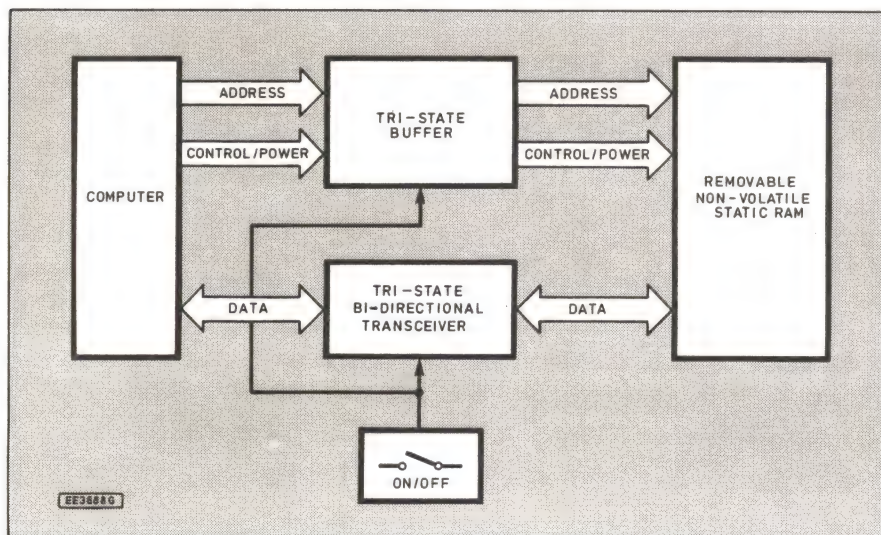


Fig. 1. Block diagram for the Quick Prom.

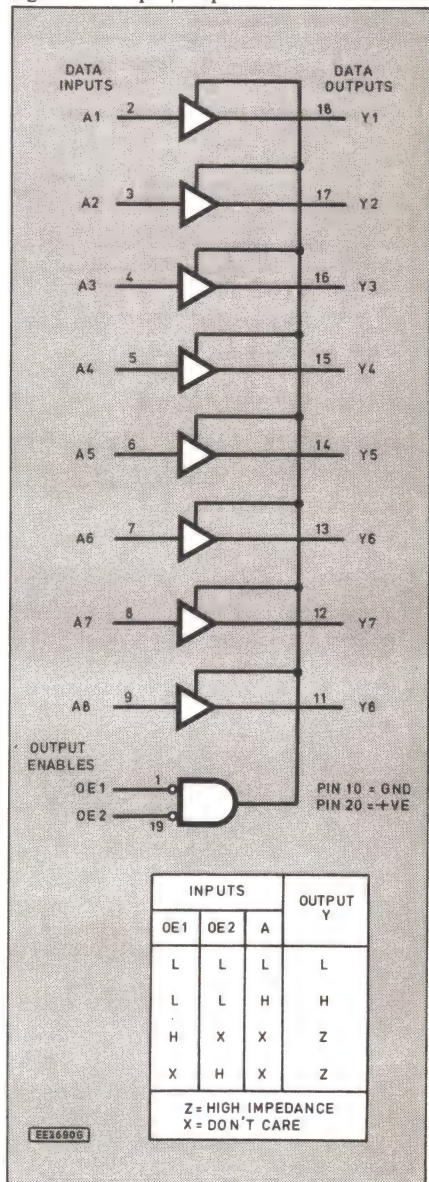
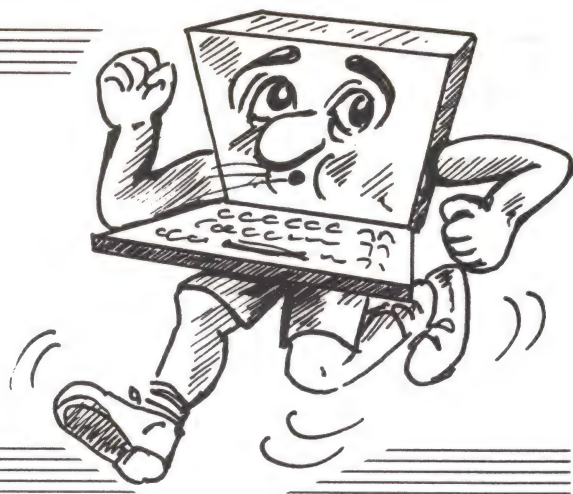


Fig. 3. Functional logic diagram and truth table for the 74C541.

from the computer's data input/output lines by IC5. This chip is an octal tri-state non-inverting bus transceiver type 74HC245. It has three modes of operation controlled by its pins 1 and 19.

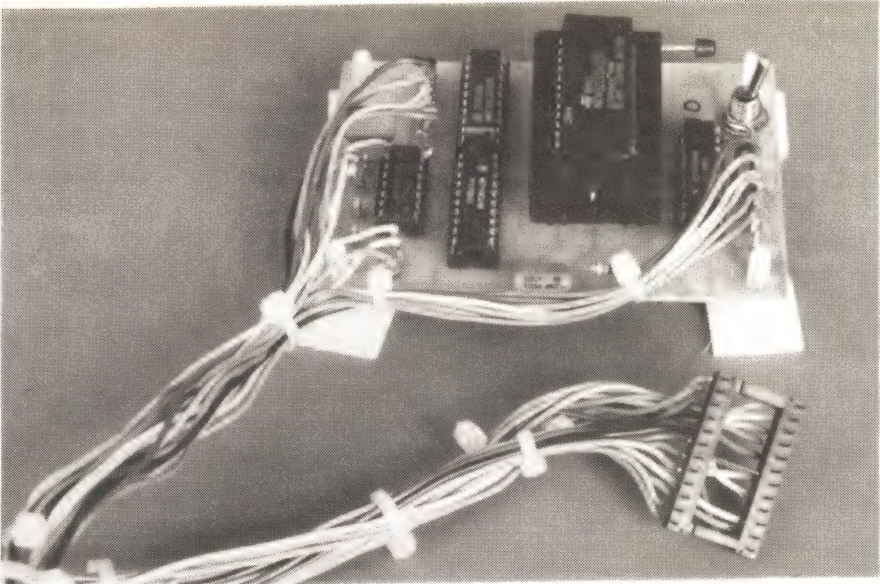
Pin 1 controls the data direction, a high logic level setting the direction from side A to side B. A low logic level reverses the direction.

Data is only transferred from one side to the other when the output enable control pin 19 is set low. When this pin is held high, the output pins are set into a high impedance state, behaving as though they are, in effect, switched off.

The SRAM IC4 has 11 address lines, the first eight of which, A0-A7, are isolated by IC2. This chip is an octal tri-state non-inverting buffer type 74HC541 whose outputs are put into a high impedance state when either pin OE1 or pin OE2 is set high. When both pins are low, data on the chip's A1-A8 inputs is transferred to the Y1 to Y8 outputs. Fig.3 shows the logic diagram and truth table for the 74HC541.

Another 74HC541 (IC3) isolates IC4's A8-A10 address lines, as well its positive power line and the WE, OE and CE control lines. Each output pin of a 74HC541 can sink or source a current of 35mA, provided that the chip's total power dissipation does not exceed 750mW. As the SRAM can draw about 70mA when fully active, power is supplied to it via two lines of IC3, along paths A7/Y7 and A8/Y8.

The output enable pins (1 and 19) of IC2 and IC3 are controlled by switch S1. When the switch is open the pins are held



at +5V via R1 – allowing the SRAM to be removed, whereas when it is closed the pins are switched direct to ground – (0V) switching the SRAM into circuit.

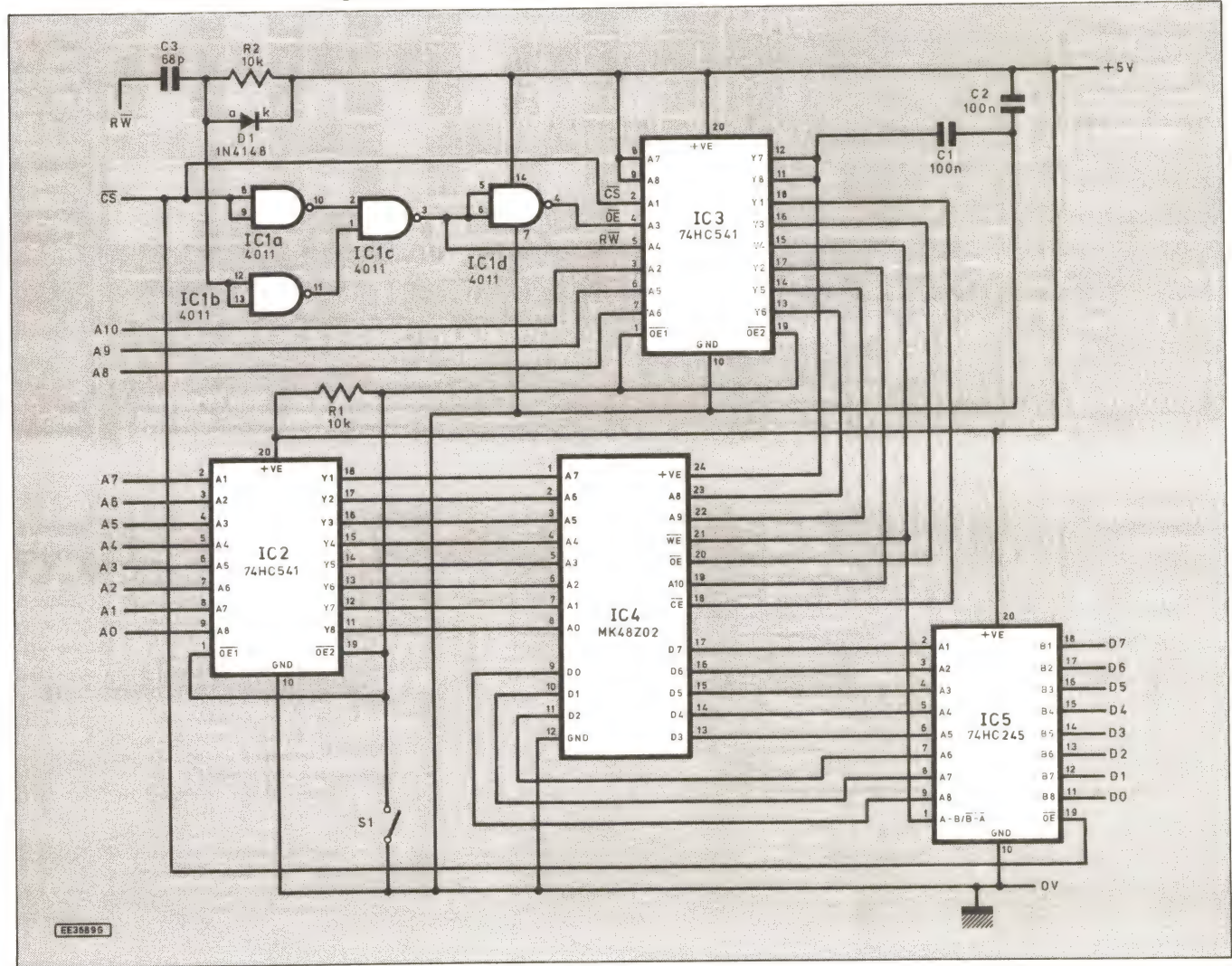
The output enable pin of IC5 is controlled by the chip select line (CS) of the computer. This line, via IC3 A1/Y1, also controls the SRAM's CE (chip enable) line at pin 18. In conjunction with the computer's read/write line (RW), CS also controls the SRAM's read/write and output enable lines, WE and OE.

The chip select (CS) is inverted by IC1a

which sets the logic on one input of the NAND gate IC1c. The other input to IC1c is controlled by the RW line generating a negative-going pulse across C3/R2 which is then inverted by IC1b. Only when both inputs to IC1c are high simultaneously will its output go low.

The output from IC1c is passed via IC3 A4/Y4 to control line WE (read/write) of the SRAM (IC4), it is also inverted by IC1d to control line OE (output enable) of the SRAM via IC3 A3/Y3. When writing to the SRAM, the computer's CS and RW

Fig. 2. Complete circuit diagram for the Quick Prom interface.



lines must both be low. When reading from the SRAM, $\overline{CS}$ must again be low, but $\overline{RW}$ must be high.

For some computers it may be possible to omit capacitor C3, resistor R2 and diode D1, taking the $\overline{RW}$ line direct to IC1b. This will depend on the synchronisation of the $\overline{RW}$ toggling relative to the data and address line timings.

The ending of the $\overline{RW}$ pulse must occur before the address and data lines change their states otherwise data intended for one address may erroneously be written into the previous address as well. The values of C3 and R2 were chosen to shorten the 1µs $\overline{RW}$ pulse generated by the computer's 1MHz system clock to about 0.5µs.

The unit is powered direct from the computer's 5V power line, which must be capable of supplying at least 80mA.

ASSEMBLY

The Quick Prom is built on a single-sided printed circuit board (p.c.b.) and the

component layout and full size copper foil master pattern is shown in Fig. 4. This board is available from the *EE PCB Service*, code EE799.

Ordinary dual-in-line (d.i.l.) sockets should be used for all i.c.s except for IC4 for which a "Zero Insertion Force" (ZIF) socket should be used. Connections between the p.c.b. and computer may be via ribbon cable or individual wires drawn together into a neat harness secured with cable ties. About one metre of cabling should be sufficient.

As constant access is needed to the board, it is probably better not to put it in a box. The switch S1 is mounted directly on the board, consequently the height of the p.c.b. supports must allow clearance for its body.

The computer with which the original unit is used has an unused 24-pin ROM socket providing all the necessary pinouts except for the $\overline{RW}$ line. Consequently, all the unit's leads except for $\overline{RW}$ were sol-

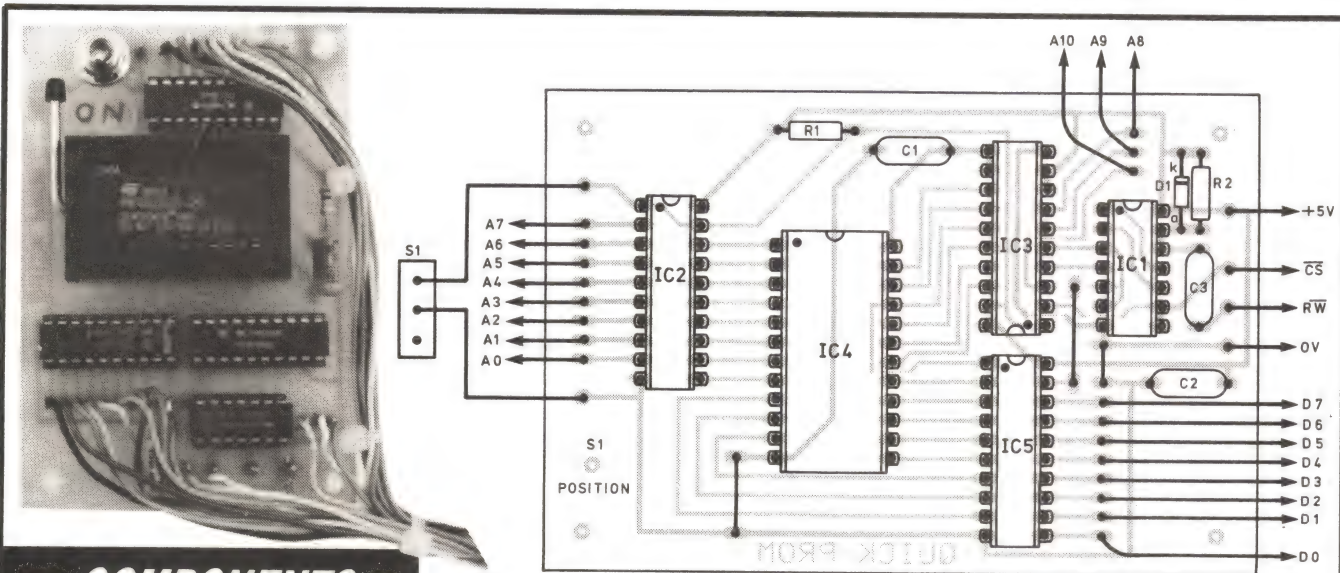
dered to the upper side of a separate 24-pin socket which was then plugged into the ROM location.

The $\overline{RW}$ lead was connected to the computer's $\overline{RW}$ line on its expansion plug. This plug could not readily be used for all the connections since a dedicated $\overline{CS}$ line is not available on it, whereas $\overline{CS}$ on the ROM location is dedicated to that specific address block.

IN USE

If your computer does not have a suitable spare socket, consult the computer manual and consider whether it is practical to temporarily remove a RAM or ROM (more likely a RAM) to allow the unit to be plugged in. Check the pinouts before wiring the 24-pin connector.

Once the unit is plugged in, the computer does not need to be switched off each time the SRAM is inserted or removed since switch S1 controls all the necessary isolation. When copying data into the SRAM,



COMPONENTS

Resistors

R1, R2 10k 0.25W 5% carbon (2 off)

Capacitors

C1, C2 100n polyester (2 off)

C3 68p polystyrene

Semiconductors

D1 1N4148 signal diode

IC1 4011 quad 2-input NAND gate

IC2, IC3 74HC541 octal buffer (2 off)

IC4 MK48Z02 Lithium battery-backed SRAM

IC5 74HC245 octal bus transceiver

Miscellaneous

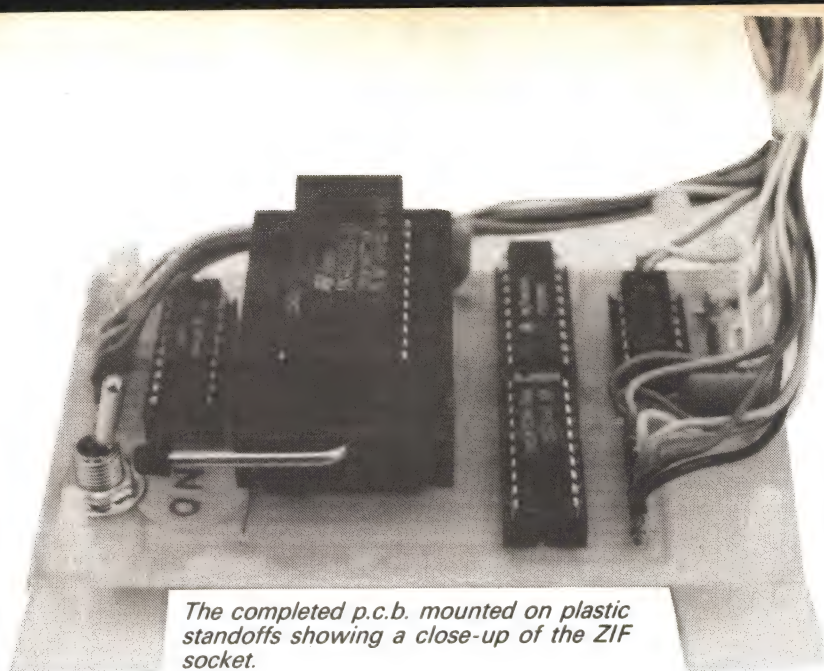
S1 s.p.s.t. min. toggle

Printed circuit board available from *EE PCB Service*, code EE799; 14-pin d.i.l. socket; 20-pin d.i.l. socket (3 off); 24-pin d.i.l. socket; 24-pin ZIF (zero-insertion-force) socket; multi-coloured connecting wire or ribbon cable (23x1 metre); nylon stand-off p.c.b. supports (4 off); cable ties, if individual wires used; solder pins; solder etc.

Approx cost guidance only

£27

Fig. 4. Printed circuit board component layout and full size copper foil master pattern. IC4 is mounted in a ZIF socket the rest are inserted in standard d.i.l. sockets. The completed board is shown top left.



The completed p.c.b. mounted on plastic standoffs showing a close-up of the ZIF socket.

switch off S1, insert the SRAM, switch on S1 (taking the OE pins to 0V), run the copy routine, switch off S1 and remove the SRAM, after which it is ready for use in the circuit you are developing.

The copying procedure will depend on what facilities you have on the computer. Some machine-code assemblers or monitors have a facility for high-speed copying of memory data from one location to another. In this case, machine code is written in the normal way and then transferred under the monitor to the unit by copying the code to the chosen ROM or RAM location.

For example, I might assemble code into RAM block \$2000-\$27FF and then

copy it to the unit plugged in at location \$9000. (Using a Supermon mini-assembler, for example, the copy (transfer) command is simply "T 2000 27FF 9000" and the process takes a mere fraction of a second.) Note that it would be inadvisable to assemble the code directly into the location at which the unit is plugged since data could be lost if a mistake is made when relocating the SRAM. It is better to assemble code at another computer memory location, save to disk, and then copy to the unit.

Copying can be done via a Basic program, albeit at a much slower rate. In the following example, the code and unit locations are the same as those above but expressed in decimal.

```

100 REM QUICK-PROM COPY
110 M=8192:REM $2000
120 S=36864:REM $9000
130 FOR A=0 TO 2047:REM SRAM
    MAX CAPACITY
140 P=PEEK (M+A):REM GET
    MEMORY DATA
150 POKE S+A,P:REM COPY DATA
160 C=PEEK (S+A):REM READ
    SRAM
170 IF C<>P THEN PRINT "ERROR
    AT ";S+A;P;C
180 REM LINE 170 VERIFIES DATA
    COPY
190 NEXT A
200 PRINT "RECHECKING"
210 FOR A=0 TO 2047
220 C=PEEK (S+A)
230 P=PEEK (M+A)
240 IF C<>P THEN PRINT "ERROR
    AT ";S+A;P;C
250 NEXT A
260 PRINT "FINISHED":STOP

```

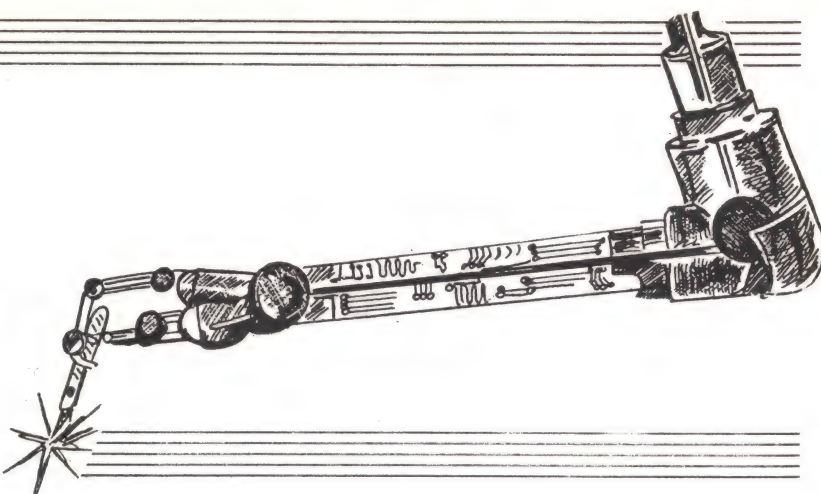
If copying errors have occurred (unlikely, but possible), the software can be written to allow for the recopying of just single bytes or short blocks from within the main memory block. It is not necessary to copy all 2048 bytes.

When system development has been completed and you are happy with the machine code, it should then be down-loaded from the computer into an E(E)PROM in the normal way via a suitable programmer. Although it might appear that this unit could be used to copy into EEPROMS, this proved impractical with my own computer because it is not capable of providing the longer write pulses necessary (typically about 10ms). □

PCB & SCHEMATIC CAD	DIGITAL SIMULATION	ANALOGUE SIMULATION	SMITH CHART CAD
EASY-PC £98	PULSAR £195	ANALYSER III £195	Z-MATCH II £195
● Design Single sided, Double sided and Multilayer boards. ● One software package for Schematics and PCB's. ● Standard output includes Dot Matrix / Laser / Inkjet printers, Pen Plotters, Photo-plotters and NC Drill. ● Award Winning EASY-PC is in use in over 12,000 installations in 70 Countries World-Wide. ● Runs on PC/XT/AT/286/386 with Herc, CGA, EGA, VGA. ● Optional libraries S.M. Components etc. From £38.00	● At last! A full featured Digital Circuit Simulator for less than £1000! ● Pulsar allows you to test your logic designs without the need for expensive test equipment. ● Catch glitches down to a pico-second per week! ● Includes 4000 Series CMOS and 74LS Libraries. ● Runs on PC/XT/AT/286/386/486 with EGA or VGA. Hard disk recommended. ● 74HC / HCT Libraries optional at £48.00 each.	● NEW powerful ANALYSER III has full graphical output. ● Handles R's, L's, C's, Bipolar Transistors, FET's, Op-Amp's, Tapped and Untapped Transformers, and Microstrip and Co-axial Transmission Lines. ● Plots Input and Output Impedances, Gain, Phase and Group Delay. ● Covers 0.001 Hz to >10GHz ● Runs on PC/XT/AT/286/386/486 with EGA or VGA displays. ● Very fast computation.	● Z-MATCH II takes the drudgery out of RF matching problems and includes many more features than the standard Smith Chart. ● Provides quick accurate solutions to many matching problems using transmission line transformers, stubs, discrete components etc.etc.. ● Supplied with comprehensive user instructions including many worked examples. ● Runs on PC/XT/AT/286/386/486, CGA, EGA, VGA. ● Ideal for both education and industry.
For full info' Phone, Fax or Write to: Number One Systems Ltd. The Electronics CAD Specialists REF: EVD, HARDING WAY, SOMERSHAM ROAD, ST. IVES, HUNTINGDON, CAMBS, PE17 4WR, ENGLAND. Telephone: 0480 61778 (7 lines) Fax: 0480 494042 International: +44-480-61778 Fax: +44-480-494042 ACCESS, AMEX, MASTERCARD, VISA Welcome.			

CIRCUIT SURGERY

MIKE TOOLEY B.A.



Welcome once again to Circuit Surgery, our regular clinic for readers' problems. This month has brought in another bumper crop of mail and, in an attempt to deal with as many of your queries as possible, I have tried to include quite a few topics this month. Hopefully, there is something for everyone.

Our July Surgery provides information on how to detect the state of a contact breaker in a magneto, the circuit of an experimental pulse comparator, and a simple a.m. radio tuner. We also revisit Mark Stuart's popular *Variable Bench Power Supply* and offer a timely warning concerning the purchase of electrolytic capacitors. For good measure we have some advice on the selection of analogue to digital converter (ADC) chips and a listing of popular logic gates by their function.

Synchronising engine speed

W. Roberts writes from Jersey to ask for some help in the design of a circuit which will allow him to adjust the timing of engines fitted to a light aircraft:

"This instrument is a project which I would very much like to build and utilize. All light aircraft maintenance workshops would most certainly have one for synchronizing and timing port and starboard magnetos on piston engines. Classic motor cycle restorers and others used to the time consuming 'cigarette paper technique' for determining opening time would undoubtedly benefit from the ease and accuracy of timing magnetos afforded by this method."

For the benefit of readers who may not

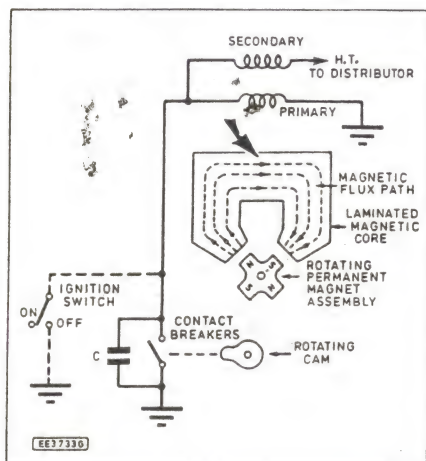


Fig. 1 Basic magneto arrangement (note that the transformer windings are wound on the laminated steel core)

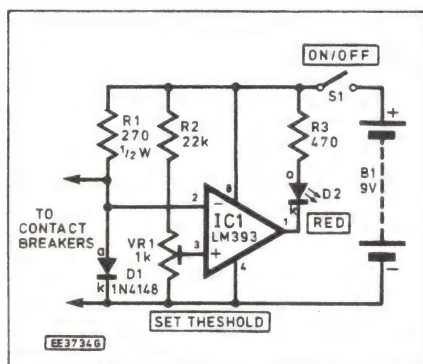


Fig. 2 Simple instrument for sensing the state of the contact breakers

know how a magneto operates, Fig. 1 shows the basic principle of this device. The important thing to note is that this form of HT generator does not require the services of a d.c. supply in order to generate the HT voltage required by the engine's ignition system.

The current in the primary winding is induced by the rotating magnet. As this current reaches a peak value, the contact breaker mechanism (which is driven by a rotating cam) opens and interrupts the primary current. This results in a sudden collapse in flux which, in turn, produces a

very high value of induced e.m.f. across the secondary winding.

Mr Roberts quotes typical values of capacitor and primary coil resistance of 2.2μF and 0.7 ohm respectively. Clearly, detecting the opening and closing of the points under static conditions will be somewhat problematic since most ohmmeters will just not be able to detect such a small change in resistance.

The circuit shown in Fig. 2 (based on a comparator) will, however, detect changes in resistance of less than 0.1 ohm. The circuit requires a 9V d.c. supply (50mA maximum) and operates an l.e.d. which will provide a visual indication whenever the contact breakers are open. The threshold sensitivity of the instrument is adjusted by means of VR1. In order to set this for optimum sensitivity, a one ohm resistor should be connected across the probes and the control is adjusted until the l.e.d. just becomes illuminated. The resistor can now be removed and the instrument will be ready for use. If necessary, the circuit of Fig. 2 can be duplicated to permit simultaneous adjustment of both engines on a twin engined aircraft.

Finally, the pulse comparator arrangement shown in Fig. 3 has been provided as "food for thought". This circuit should be capable of adaptation for use in synchronizing the speed of two engines

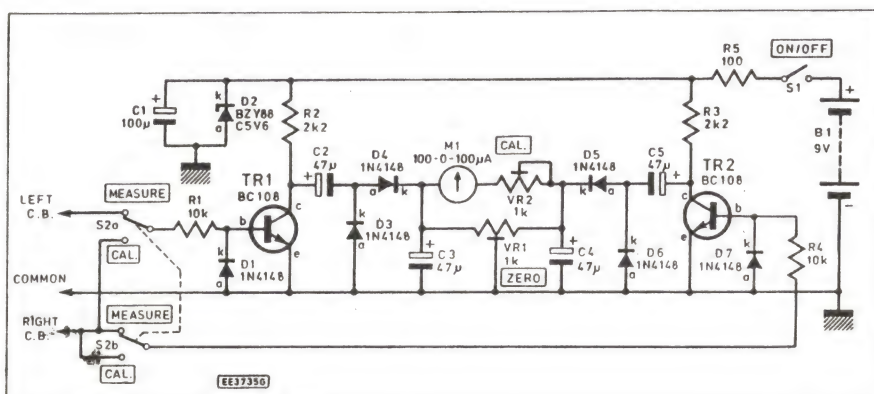


Fig. 3 Circuit of the experimental pulse comparator

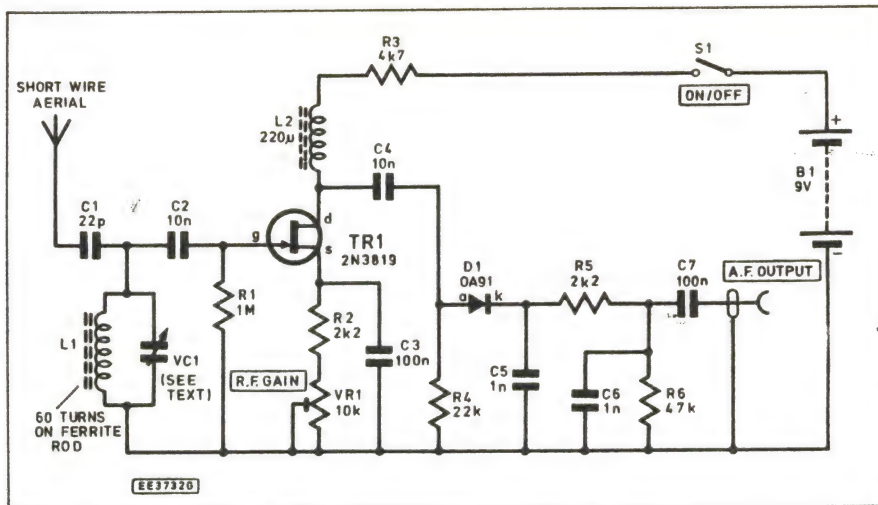


Fig. 4 Circuit of the simple a.m. tuner

when the engines are actually running. It should be noted that the circuit assumes that both contact breakers interrupt the current for an identical proportion of the cycle. The circuit has been "bench tested" and, with the values quoted, it was found quite possible to detect synchronism of two pulse trains to within two per cent.

Simple a.m. tuner

Many of today's audio systems are fitted with tuners which only receive f.m. signals. This can be something of a problem when the user wishes to receive one (or more) a.m. stations on the medium or long-wave band! For such occasions, and provided that only local station reception is required, a simple single-stage a.m. tuner can suffice. Fig. 4 shows the circuit of such an arrangement.

The tuned circuit L1/VC1 comprises an inductor wound on a conventional ferrite rod and a variable capacitor (having a maximum value of between 200pF and 500pF) both of which can be removed from a discarded radio. TR1 (a field-effect device) provides a small amount of r.f. gain and its high input impedance is ideal for directly matching the input tuned circuit. The r.f. gain is made variable by means of VR1. This control is adjusted to produce a satisfactory value of gain coupled with a sufficiently "sharp" degree of selectivity in order to eliminate strong a.m. signals which may be present on adjacent frequencies.

A short length of aerial wire (not more than about three metres) may be necessary in order to receive signals at the high frequency end of the medium waveband. In some cases, it may also be necessary to experiment with the inductor (L1) for optimum results.

The output of the a.m. tuner may be taken to the "auxiliary" input of almost any hi-fi audio amplifier. This input will usually exhibit an input impedance of about 50 kilohms. This will usually have sufficient sensitivity to provide ample volume from the 20 to 100mV output signal obtained from the a.m. tuner.

Versatile Power Supply

Mark Stuart's *Variable Bench Power Supply* was featured in the February 1988 issue of *Everyday Electronics*. This circuit provides a d.c. output fully variable over the range 0V to 24V at up to 2.5A. The design was somewhat unusual in that it used a power MOSFET rather than the

usual 2N3055 (or similar) series-pass transistor. Mark's circuit also employed a quad operational amplifier (LM324) and offered separate output voltage and current limit controls.

Mr R. Bolton writes from Pendlebury with a query concerning this popular constructional project:

"All voltages are OK and the voltmeter works however the ammeter and op-amp output all read zero. There is only 2.6mV across R13 (0Ω1) which gives 0.104V at pin-14 which should be 10V varying to 0V as the pot is rotated.

The power supply is a "must" for my benchwork but I am stuck. Perhaps a breakdown of the circuit would be an answer to my problem."

Well, Mr Bolton, I am not really certain that you DO have a problem! One piece of useful information which you have not given me is what happens when you place a load on the power supply. I assume that the readings you have quoted are under "no-load" conditions. If this is the case, they are not far from what should be expected!

Try placing the unit under load (a current of a few hundred mA would be useful) and see if the voltage drop across R13 increases. Then adjust the current limit control (VR1) and check that the output voltage falls to zero when the limiting value has been reached.

If the voltage dropped across R13 does not increase and the ammeter (ME1) still

fails to produce an indication, then you DO have a fault! If there IS a voltage drop across R13 (but no indication on the ammeter) it would be worth replacing IC1 (the LM324) with another device. Failure of IC1b would certainly give rise to the conditions which you describe.

Finally, it is worth pointing out that the voltage at pin-14 does not behave in quite the way in which you suggest. This voltage is simply an amplified version of that which is dropped across R13. It will not normally be affected by the setting of the current limit control (VR1) unless the circuit has begun to "current limit".

If any other reader has had any problems with Mark Stuart's *Variable Bench Power Supply* (or can throw any other light on this subject) please drop me a line! Incidentally kits for this design are available from Magenta Electronics Ltd who advertise in EE.

Analogue to digital conversion

Matt Manktelow writes from Co. Antrim, Northern Ireland, to ask if I can suggest a suitable chip for use in an analogue to digital converter. Matt has asked particularly for a device which can be interfaced with a computer so I have searched through my data library in order to find a short-list of suitable devices.

All of the devices listed are "micro-computer bus compatible". This means that their outputs can be connected directly to a microprocessor data bus without having to resort to the use of a parallel interface device. In order to avoid an unwanted conflict of data on the bus, the ADC output must only be enabled when it is actually being addressed by the microprocessor. To ensure that this is the case, additional address decoding logic will be required.

The ADC will be allocated an address within the system I/O or memory map (depending upon the microprocessor type involved). Assuming that the system is based on a common 8-bit Z80 microprocessor, the ADC should be allocated a unique I/O address (chosen so as to avoid conflict with other I/O devices which may be present). Reading the data from the ADC is then a relatively simple matter of executing a port input instruction (this has the form IN A,(port) where port is the address of the ADC. In a practical system, the "data available" output of the ADC chip is used to generate an interrupt request (via the active-low IRQ line).

ADC Chips

Number of channels (note 1)	Resolution (bits) (note 2)	Device type number	Package	Special features
1	10	AD573	20-pin d.i.l.	
1	8	AD7575	18-pin d.i.l.	High speed
1	12	AD7578	24-pin d.i.l.	
8	8	AD7581	28-pin d.i.l.	
1	12	AD7672	24-pin d.i.l.	High speed
1	8	ADC0804	20-pin d.i.l.	
4	8	ADC0844	20-pin d.i.l.	
1	12	ADC511	24-pin d.i.l.	Low power
1	8	ZN427E	18-pin d.i.l.	
1	8	ZN439E	22-pin d.i.l.	
1	8	ZN448E	18-pin d.i.l.	
1	8	ZN502E	20-pin d.i.l.	

Note 1: The "number of channels" specifies the number of analogue inputs that may be connected to the ADC chip. Where more than one channel is provided for, the device in question will incorporate some form of analogue multiplexer.

Note 2: The basic resolution of an ADC chip is dependent upon the number of bits used to represent the analogue input. The greater the number of bits, the smaller the change in analogue input level that can be detected by the device.

Basic logic functions

Matt Mantelow has also asked me to list some of the more common logic gates according to their function. So, here goes:

Logical AND function

Number of gates per package	Number of inputs per gate	Gate type	Other characteristics
4	2	74LS08	Open collector
4	2	74LS09	
3	3	74LS11	
3	3	74LS15	
2	4	74LS21	

Logical OR function

Number of gates per package	Number of inputs per gate	Gate type	Other characteristics
4	2	74LS32	
3	3	4075	
4	2	74LS136	

Logical EXOR (exclusive-OR) function

Number of gates per package	Number of inputs per gate	Gate type	Other characteristics
4	2	74LS86	
4	2	74LS136	
4	2	74LS386	

Logical NAND function

Number of gates per package	Number of inputs per gate	Gate type	Other characteristics
4	2	74LS00	Open-collector
4	2	74LS01	
4	2	74LS03	
3	3	74LS10	
3	3	74LS12	
2	4	74LS13	Schmitt input
4	4	74LS20	
4	4	74LS22	Open-collector
4	2	74LS26	
1	8	74LS30	High-voltage
4	2	74LS37	
4	2	74LS38	Buffer
2	4	74LS40	
4	2	74LS132	Schmitt input
1	13	74LS133	

Logical NOR function

Number of gates per package	Number of inputs per gate	Gate type	Other characteristics
4	2	74LS02	Strobe
2	4	74LS25	
3	3	74LS27	
4	2	74LS28	Buffer
4	2	74LS33	
4	2	74LS266	Exclusive
2	4	4002	
1	8	4078	

The foregoing lists are not exhaustive but should cover the vast majority of eventualities. The 'LS' series of TTL devices is available from a great many component suppliers but I have listed a few useful CMOS devices as well.

Caveat emptor

"Next time you purchase electrolytic capacitors, take a careful look at the markings!". This is the timely advice offered by Colin Pickwick. He recently purchased some capacitors (from a well established supplier) only to find (on close examination) that the marked working voltage was well below the advertised value.

It would appear that either the values had been substituted by the supplier (without warning) or the capacitors had been mistaken for components having an identical capacitance value but with a much reduced voltage rating. In some cases this would not matter too much, however there could very well be serious implications of operating a component at a potential which is appreciably greater than its rated voltage.

Readers will doubtless already be well aware that the voltage ratings quoted for electrolytic capacitors are really quite important. As an example, a capacitor rated at 16V will invariably not operate safely in a circuit which specifies a component rated at 35V. The moral to this little story must therefore be that it is always worth checking that the components you receive from a supplier are the ones that you actually ordered!

Next month: In next month's Surgery we shall be describing an improved low-battery warning indicator and have a computer program for designing 555 timer circuits.

DROP ME A LINE

If you have any comments or suggestions for inclusion in *Circuit Surgery*, please drop me a line at: Faculty of Technology, Brooklands College, Heath Road, Weybridge, Surrey, KT13 8TT. Please note that I cannot undertake to reply to individual queries from readers however I will do my best to answer questions from readers through the medium of this column.

Note: If you have a specific query on an EE project see the information under *Readers Enquiries* on the Editorial page and write to the Editorial Offices at the address shown at the top of that page.

EVERYDAY ELECTRONICS

NEWSAGENTS ORDER FORM

Please reserve/deliver a copy of
Everyday Electronics for me each month

Signed.....

Name and Address.....
(BLOCK CAPITALS PLEASE)

Everyday Electronics is published on the first Friday of each month and distributed by Seymour.
Make sure of your copy of EE each month - cut out this form, fill it in and hand it to your newsagent.

LASER SCIENCE



We supply all Laser and associated optical components at low, low prices.

SPECIAL OFFER

High Powered
5mW Visible Hene Laser Tubes.
£55.00 each. (inc.PSU Plans)

Easy to set up and operate.
These are new & direct
from the factory.
Not to be confused
with the usual lower
powered devices
on offer.

For Information on Lasers, Optics,
Holography Kits, Plans, Books etc...
Send S.A.E. To: Laser Science Ltd.
P.O.Box 79, Prestwich, Manchester M25 5AT
TEL: 061 773 0911. FAX: 061 773 0912

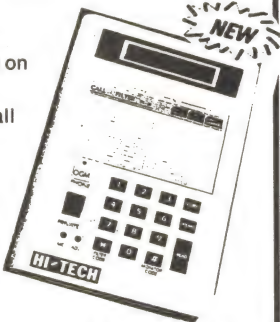


THE NAME IN INNOVATIVE
COMMUNICATIONS PRODUCTS

STOP NUISANCE CALLS PROTECT YOURSELF AGAINST UNWANTED TELEPHONE CALLS

DL20 TELEPHONE CALL FILTER-MONITOR-ANSAPHONE

- ★ Call-Screen: Displays the number of incoming calls before the telephone is answered.
- ★ Call-filter: No more unwanted calls.
- ★ Call-Counter: Check number of calls on return.
- ★ Call-Register: Stores 40 incoming call numbers and the time of the call.
- ★ Call-Monitor: Listen to any noise in your home/office by a secret code when calling.
- ★ Normal time display.
- ★ Memory back-up during power cut.
- ★ Can connect both tone or pulse telephone systems.
- ★ 20 phone number memories can be stored and recalled.
- ★ OGM: To record a personalised outgoing message.



£118.29

All prices are exclusive of VAT. £3 p&p

NORTHERN MARKETING CONCEPTS

24 HOUR ORDER HOTLINE
Tel: (09442) 8887



Also suppliers of -
SCANNERS - TELEPHONE RECORDERS - COMPUTER AIDED
SURVEILLANCE SOFTWARE

Please note that certain equipment may need approval before connection or use.

OUT NOW!

Summer '92 Electronic Constructors Catalogue



*Many new
products including:*

- **Audio Amplifier Modules**
Range of 14 high power audio modules, encapsulated to an integral heatsink in Bi-polar, MOSFET and Class A formats with power outputs from 15 to 180 watts.
- **Books**
18 new titles from the top electronics publishers.
- **Burglar Alarm**
Volumetric alarm triggered by change in air pressure eg an opening door, easy to install - no wiring required.
- **Spectrum Analyser Adaptor**
Converts a conventional scope into a low cost, 250MHz spectrum analyser.
- **Low Profile Mains Transformers**
Encapsulated, top quality PCB mounting mains transformers.
- **Airband Scanning Receiver**
100 programmable channels, covering civil and military frequencies.
- **Stereo Valve Amplifier**
Top quality stereo hi-fi amp from Velleman - at a very competitive price!
- **Extended Ranges**
of connectors, equipment cases, filters, crystals, fuses, fans, kits, ATUs, semiconductors, loudspeakers, sounders and toroidal transformers.

*With 24 product sections, 192 pages,
3000+ lines and £££s of discount vouchers,
be sure to get your copy now!*

Available from most newsagents or
directly from Cirket.

£1.70
+ 30p p&p

Cirket



CIRKIT DISTRIBUTION LTD

Park Lane · Broxbourne · Hertfordshire · EN10 7NQ
Telephone (0992) 444111 · Fax (0992) 464457

INFORMATION TECHNOLOGY

AND THE NATIONAL CURRICULUM

T. R. de VAUX BALBIRNIE

PART 9

THIS is the ninth in a 12-part series concerning Information Technology, Logic Systems and related matters in and around the Science National Curriculum. We shall devote the whole of this month to *bistable-based* circuits.

HAPPY FAMILIES

The bistable is a circuit which is stable in either of two states – hence its name. It is a member of the *multivibrator* family the other two of which are the *monostable* and the *astable*. Readers who have been following this series will remember that the latter pair were met in Part 5 (March, 1992 issue). It will now be useful to describe all three using mechanical models since this shows where the bistable fits into the complete picture.

Imagine we have a swinging pendulum (a piece of string with a weight on the end) – see Fig. 1a. We could think of the extremes of its swing to be called states A and B. We can see that the pendulum is not stable in either of these states. No sooner has it reached A than it reverses and goes to B, returns to A and so on. This is a mechanical *astable*.

Now imagine we lift a marble above the table (Fig. 1b) we can call the raised-up position state A and table level, state B. Here, the object is only stable when it is on the table. If it is raised and released it will fall from state A to state B and remain there. This is a mechanical *monostable* – it is stable in only one state.

Now think of a two-section piece of egg box and a marble (Fig. 1c). We could place the marble in one hole (state A) and it would remain there indefinitely. We could equally well have placed it in the other hole (state B) and it would similarly remain there. It appears that the marble is stable in *either* of the two states. This is a mechanical *bistable*.

Although it helps to illustrate the multivibrator family in this way, here we are really concerned with the *electronic* version.

FLIP-FLOPS

Today, bistables used in practical circuits almost invariably take the form of *integrated circuits*. However, bistables based on individual transistors are some-

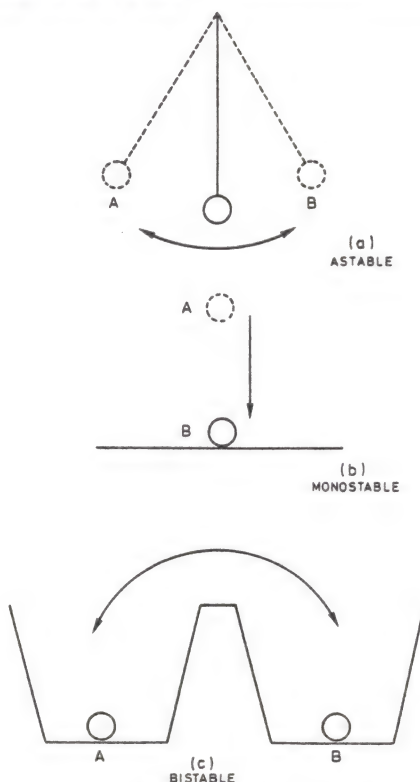


Fig. 1. Mechanical models of the multivibrator family.

times used and valves were used for the purpose many years ago. The bistable has some important uses in information handling, some of which are to make a circuit latch, to make *binary counters* and *frequency dividers* also to store data – that is, to provide *computer memory*.

Readers who have not been following the series are advised to read Part 6 (April, 1992 issue). This gives certain background information about logic gates which form the basis of bistables.

The bistable is often called a “flip-flop” because you can “flip” it into one state or “flop” it into the other. The simplest electronic flip-flop is a form of *Set-Reset* (S-R) bistable consisting of the pair of cross-coupled NOT gates shown in Fig. 2. This circuit has two outputs (one to represent each state) called Q and $\bar{Q}$ (pronounced Q bar).

The significance of these names is that

Q and $\bar{Q}$ normally have opposite logic states – that is, if one of them is Logic 0, the other will be Logic 1. In the mechanical analogy, this is like saying that when the marble is in state A (Logic 1) it is *not* in state B (Logic 0). The bistable has two inputs – one called Set (S) and the other Reset (R). These are used to change the output states as required. Fig. 3 shows the symbol for an S-R bistable.

HOW IT WORKS

In theory, an S-R bistable could be built from the arrangement of NOT gates shown in Fig. 2. However, this is not a practical circuit and, although simple, would be difficult to control. It is best not to build it at all but to *imagine* how it would work. Consider the instant when the supply (not shown) is connected. The output states of both gates would be 0 (because nothing has happened yet).

Now consider Gate A. Since its output ($\bar{Q}$) is 0 the input to gate B (R) will also be 0 because they are connected together. A NOT gate inverts the logic state of the input so the output of Gate B (Q) will become 1 and this makes the input of gate A (S), 1 also. The output of Gate A will therefore remain 0. The existing states of the outputs, Q = 1, $\bar{Q}$ = 0, are therefore

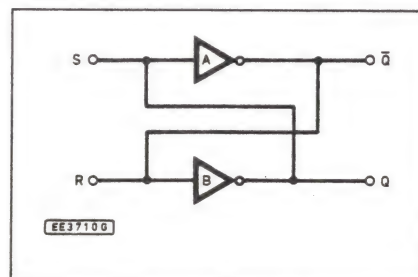


Fig. 2. NOT gate bistable.

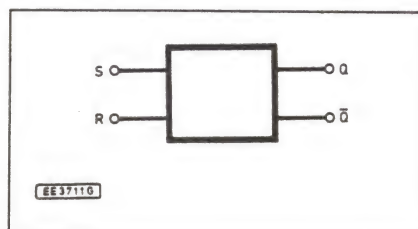


Fig. 3. Symbol for S-R bistable.

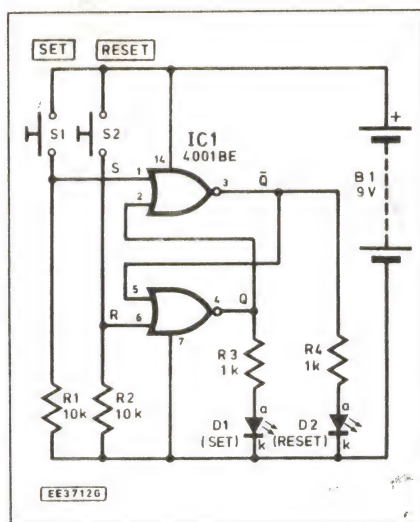


Fig. 4. Practical S-R bistable.

maintained – that is, the bistable is *stable*. This is called the *Set* condition.

We must, however, consider what would have happened if the 0 state at Gate B output (Q) had given Gate A an output of 1 first. This state would have been fed to Gate B input whose output would therefore be 0. This condition, $Q=0$, $\bar{Q}=1$, would be equally stable and is called the *Reset* condition. It appears, therefore, that whether $Q=1$ and $\bar{Q}=0$ or $Q=0$ and $\bar{Q}=1$, depends on which gate processes the information presented to its input first – there is a *race* between the two gates.

Since no two gates are identical, one will always do this first. The bistable will therefore power-up in either the *Set* or *Reset* condition. Such racing is not good because it introduces an unpredictable element and is avoided in real systems.

Suppose on switching on, the bistable is *Set* ($Q=1$, $\bar{Q}=0$). By making $R=1$, Q will be forced to become 0 and $\bar{Q}$, 1 – the outputs will change states i.e. it is *Reset*. If S is now made 1, the outputs will revert to their *Set* conditions.

A PRACTICAL S-R BISTABLE

To be useful, a bistable needs to have more sophisticated access to its inputs. With the NOT gate bistable, the inputs are connected *direct* to outputs. This means that in controlling the inputs, the outputs can be short-circuited.

A practical S-R bistable circuit which does not suffer from the problem mentioned above is shown in Fig. 4. This consists of a pair of cross-coupled NOR gates. Switches, S1 and S2 respectively are used to set and reset the device and l.e.d's, D1 and D2 indicate the logic state of the outputs, Q and $\bar{Q}$ – when *lit* the state is 1, when *off*, it is 0.

As a basis for this month's experiments, the simplest approach is to use a modular kit (for example, the Unilab Alpha Kit). Alternatively, circuits may be built using basic components on a Plugblock (prototype board) – layouts are given in all cases.

Note that a description of the Plugblock and its use in circuit-building was given in Part 5 (March, 1992 issue).

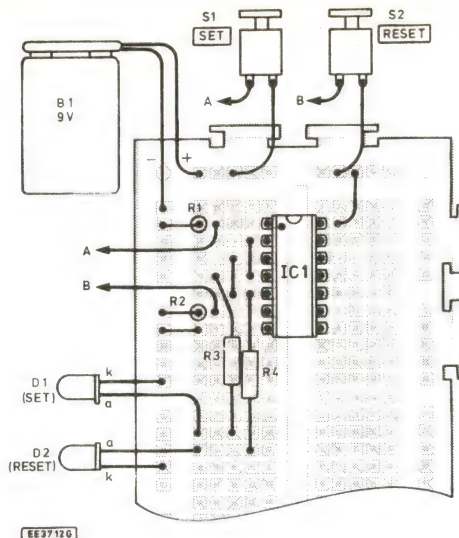


Fig. 5. Practical S-R bistable construction.

The component “shopping lists” assume the use of the Plugblock and a few short pieces of single-strand connecting wire to be used as link wires. A PP3 or other 9V battery and a suitable connector are also needed.

Remember, if you have been building circuits from previous parts of the series, check your stock of components before ordering new ones. Special *low-current* l.e.d's are available from several suppliers and it is worthwhile using them. Ordinary l.e.d's may be used but they will not be as bright.

To build the practical bistable you will need the following:

- IC1 4001BE quad. NOR gate
- R1, R2 10k resistors (2 off)
- R3, R4 1k resistors (2 off)
- D1, D2 5mm low-current red l.e.d.s (2 off)
- S1, S2 light-duty push-to-make switches (2 off)

Following the Plugblock layout (Fig. 5). Note that two of the four NOR gates contained within the 4001 chip are used. Resistors, R1 and R2 are “pull-down” resistors which keep the inputs at logic 0 (negative battery voltage) when switches S1 and S2 are released. This prevents possible false operation.

The l.e.d's must be connected the correct way round or they will not work – the shorter lead denotes the cathode (k) end. When complete, connect the battery and note that one output assumes a Logic 1 state and the other, a 0. You should find that you can change the output states by pressing the appropriate *set* or *reset* switch.

The S-R bistable operates as follows. When the battery is connected, all inputs and outputs first assume Logic 0. Since a NOR gate will produce a Logic 1 output when both inputs are at Logic 0, it follows that the race condition occurs. There will be a competition between the two gates to process this information and one output will take on a Logic 1 state before the other. This will be applied to the input of the other gate making its output 0. The

bistable will now be in a stable condition.

Suppose it is output Q which assumes the 1 state and output $\bar{Q}$ is 0, that is, the bistable is *set*. A Logic 1 pulse applied to the Reset input now changes the output states to $Q=0$, $\bar{Q}=1$. This is because Logic 1 applied to the Reset input will make Q Logic 0 (a NOR gate produces a Logic 1 output only if *both* inputs are Logic 0). This then feeds the input of the other gate making this Logic 0 too. The corresponding output, $\bar{Q}$, will then assume Logic 1. It will then remain like this until the circuit is Set by making $S=1$ whereupon Q will become 1 and $\bar{Q}$, 0.

Unlike the NOT gate bistable, the Set and Reset inputs are not directly coupled to outputs so there is no chance of short-circuits occurring. The best way to summarise the action of the S-R bistable is by using a truth table:

S	R	Q	$\bar{Q}$	Notes
0	0	1	0	Initial conditions
	or 0	1		– unpredictable
1	0	1	0	Set pulse applied
0	0	1	0	Set pulse removed – no change state
0	1	0	1	Reset pulse applied – outputs change state
0	0	0	1	Reset pulse removed – no change to outputs

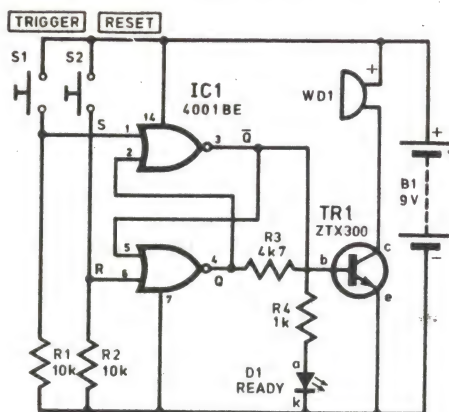
The table above resembles the truth table for a gate but, although the circuit is made from gates, it is not itself a gate. In a gate, the output is always the same for any given set of input conditions. Here, the outputs depend on the states they had previously that is, $Q=1$, $\bar{Q}=0$ if S was 1 previously and $Q=0$ and $\bar{Q}=1$ if R was 1 previously. This being so, we could say that the bistable has *remembered* what the input states were – it has *memory* whereas a simple gate has not. This is very important because it is the basis of *computer memory*.

BURGLAR ALARM

The S-R bistable may be used to illustrate a burglar alarm. When an intruder opens a door or window and operates a switch, a Logic 1 pulse is given to the *set* input. Output Q then assumes Logic 1 (equivalent to being a battery positive voltage). This operates a transistor or a relay (see Part 6: April, 1992 issue) and switches on a siren or bell. Nothing the burglar can do will silence the alarm since once the bistable has *set*, it will remain like that until *reset*. For security, the reset switch is situated in a secret place and may be key-operated.

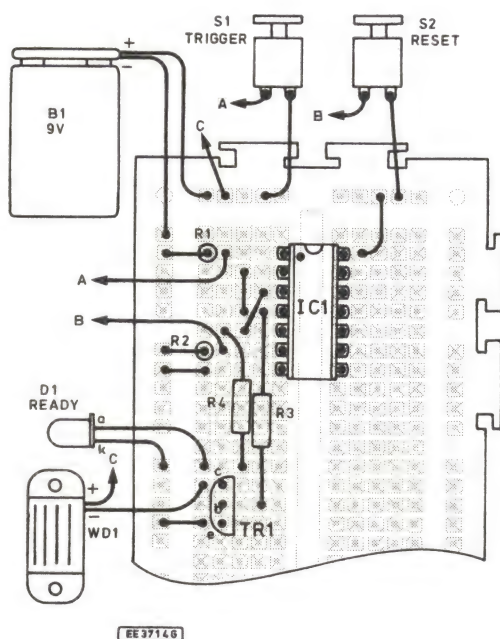
Build a model of the burglar alarm (Fig. 6 and Plugblock layout Fig. 7). Assume the bistable is *set* by pressing the TRIGGER switch, S1, Q becomes 1 and current passes to the base of transistor, TR1, via resistor R3 and operates buzzer, WD1. S2 may subsequently reset the bistable and cancel operation. The l.e.d, D1, operates when $\bar{Q}=1$ (i.e. when *reset*) and indicates the standby (READY) state.

Note that buzzer, WD1, is polarity-sensitive and must be connected the cor-



EE37136

Fig. 6. Demonstration burglar alarm.



EE37146

Fig. 7. Burglar alarm Pluglock layout.

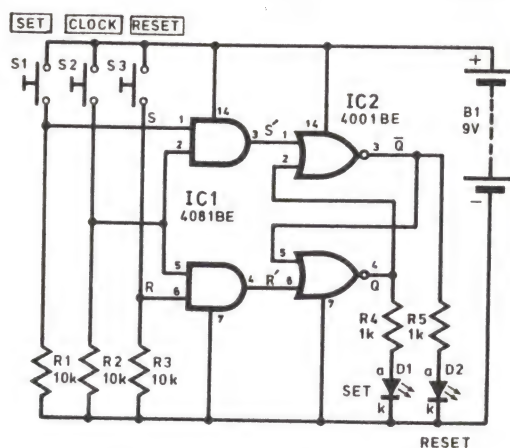
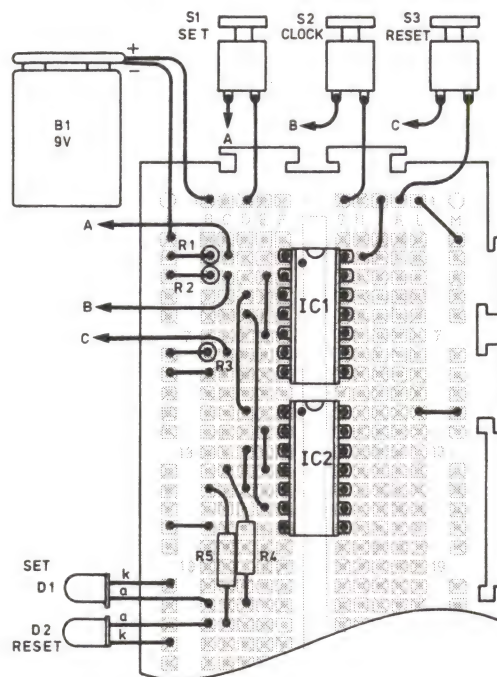


Fig. 8. Clocked S-R bistable.



EE37168

Fig. 9. Clocked S-R bistable layout.

rect way round in the circuit or it will not work – the red wire is the positive one. Note also the orientation of transistor TR1. When the battery is first connected, the buzzer may sound if Q happens to be left high (i.e. set) due to the race condition mentioned earlier.

In addition to the components used previously, you will need the following:

R3 4k7 resistor.

TR1 Transistor ZTX300 npn silicon.

Solid-state buzzer –6V operation.

CLOCKED S-R BISTABLE

It is sometimes useful to allow the Set or Reset condition to take effect only when a pulse is applied to a third input called the Clock (Ck). This allows input conditions to be set up in advance.

The circuit for a clocked S-R bistable is shown in Fig. 8. This consists of an S-R bistable with inputs S' and R', controlled by the outputs of a pair of AND gates. Only when a Logic 1 pulse is applied to

Ck (clock input) is it possible for data applied to the S and R inputs to be allowed through to the bistable proper and take effect. This is because an AND gate needs both inputs to be Logic 1 for the output to be Logic 1. The clocked S-R bistable can be built using the Pluglock layout shown in Fig. 9.

In addition to the components used previously, you will need the following

IC1 4081BE quad. AND gate

S1 Light-duty push-to-make switch

R1 10k resistor

Push-button switch, S2, applies clock pulses. When the battery is connected, the initial output states are unpredictable due to the race condition. Pressing the Set or Reset button should have no effect. Now, keeping the appropriate Set or Reset switch pressed, apply a clock pulse. The bistable will set or reset – try it a few times.

THE D-TYPE BISTABLE

The D-type is a special variety of

clocked bistable with several uses in electronics. Its symbol, and a practical circuit to illustrate how it works, are shown in Fig. 10. The D-type bistable has two inputs – one called Data (D) and the other, Clock (Ck).

The D-type bistable operates as follows. When data – that is, a 1 or a 0 – is applied to the D input, nothing happens. However, when a clock pulse is applied to Ck, output Q assumes the same state as D and output Q the opposite one. For example, if we put a logic state of 1 on the D input and give a Logic 1 pulse to Ck, Q will become 1 and Q, 0. If we subsequently put a 0 on the D input then apply a clock pulse. Q and Q will change states i.e. Q = 0 and Q = 1.

The clock pulses have no effect if the data applied to D has not changed. The action of the D-type bistable should be compared with the simple clocked S-R bistable.

Operation of the D-type bistable may be illustrated using the circuit shown in

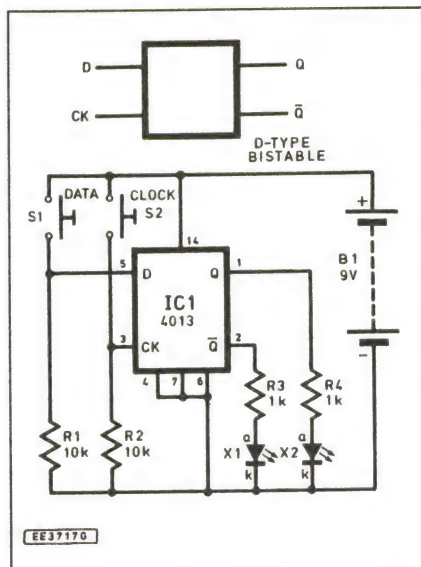


Fig. 10. D-type bistable symbol and a practical circuit.

Fig. 10. Note that the 4013 chip contains two separate D-type bistables but here we are using only one of them. In addition to previously-used components you will need:

IC1 4013 dual D-type bistable
Switch S1 supplies the data – when pressed, $D=1$ when released $D=0$ (due to the effect of pull-down resistor, R1). A clock pulse is given by pressing switch, S2. Light-emitting diodes, X1 and X2 indicate the logic states of $\bar{Q}$ and Q respectively. **Note that from now on in this series, i.e.d's are denoted by X1 and X2 instead of D1 and D2 to avoid possible confusion later with the data inputs D1, D2 etc.**

Following the plugblock layout shown in Fig. 11. The connections between pins 4 and 6 and the battery negative line keep the unused inputs which exist on the 4013 at Logic 0 and prevent false operation. Connect the battery. The outputs, Q and $\bar{Q}$, should have opposite states that is one i.e.d. will be on and the other one off. Say $Q=0$. Make $D=1$ by pressing S1 and, *keeping it pressed*, apply a clock pulse. The data will transfer from D to Q i.e. $Q=1$, $\bar{Q}=0$ (X2 on, X1 off). This is how it will

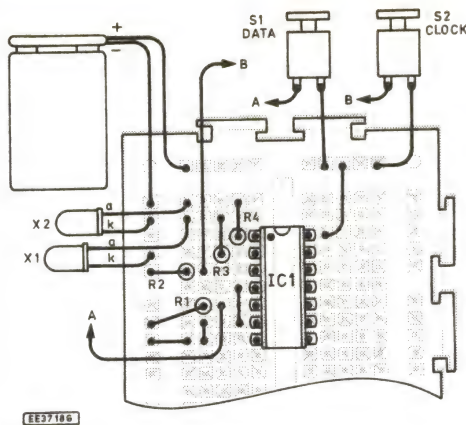


Fig. 11. D-type bistable construction.

remain until fresh data is applied and a further clock pulse given.

If S1 is left unpressed then $D=0$ and when a clock pulse is given, this will be transferred to Q (X2 off, X1 on). Check that clock pulses have an effect only when the data applied to the D-input is *new*. In this way, a single D-type bistable can remember one binary digit – or 0 or a 1. It could therefore be called a *1-bit data latch*.

THE 2-BIT DATA LATCH

A data latch remembers binary numbers and this is often useful in IT systems. Some basic information about Binary Arithmetic was given in Part 7 (May, 1992 issue). It is now helpful to consider a 2-bit number since this shows the general principle of operation. Although a 1- or 2-bit latch is not in itself very useful any larger number may be accommodated by having more flip-flops – one for each bit. The 4013 i.c. contains two independent bistables so a 2-bit latch may be made using only one chip.

The circuit for the 2-bit data latch is shown in Fig. 12 and the Plugblock layout in Fig. 13. No additional components are needed to build this circuit. If a 2-bit number is set up on Data inputs D1 and D2 using switches S2 and S3, this number can be “remembered” by giving a momentary clock pulse using S1. Note that the clock input is common to both bistables.

After building the 2-bit data latch, connect the battery and check operation by

setting up a binary number such as 10. Remember, for Logic 0 the appropriate switch is left unpressed. Now *keeping the data switch or switches pressed*, apply a clock pulse. The data transfers to the Q outputs and the flip-flops latch; i.e.d's, X1 (for Q1) and X2 (for Q2) then display the number. Fresh data may be supplied and a further clock pulse given. Try all possible 2-bit numbers – 00, 01, 10 and 11.

TOGGLING A BISTABLE

It often happens that we wish to change the status of the bistable outputs with successive clock pulses. That is, on the first clock pulse $Q=1$, $\bar{Q}=0$ on the second $Q=0$, $\bar{Q}=1$ and so on. This action is called *toggling* . It is easy to achieve with a D-type bistable by connecting the $\bar{Q}$ output to the D input (see

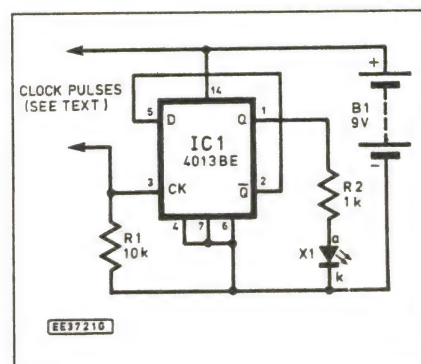


Fig. 14. Toggling a bistable.

Fig. 14). Think the operation through before actually building the circuit.

Consider the situation where $D=1$ and a clock pulse is applied. Q will become logic 1 i.e. $Q=1$ and $\bar{Q}=0$. Since $\bar{Q}$ is connected to D, D now becomes 0. On the next clock pulse this is transferred to Q i.e. $Q=0$ and $\bar{Q}=1$. This state of 1 is again transferred to the D input i.e. $D=1$. On the next clock pulse this 1 will be transferred to Q so $Q=1$ and $\bar{Q}=0$. This sequence of events repeats indefinitely.

Note that the number of times Q changes state is one half the number of times the clock is pulsed. We have therefore *divided the number of clock pulses by 2* – that is, we have made a frequency

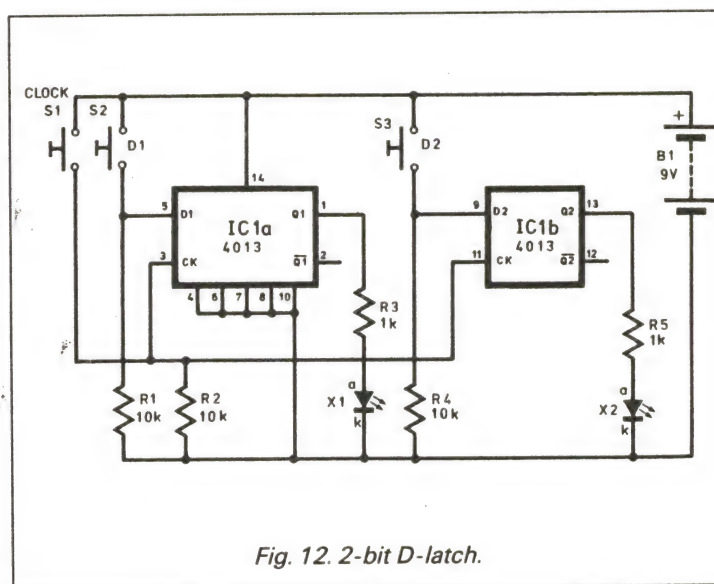


Fig. 12. 2-bit D-latch.

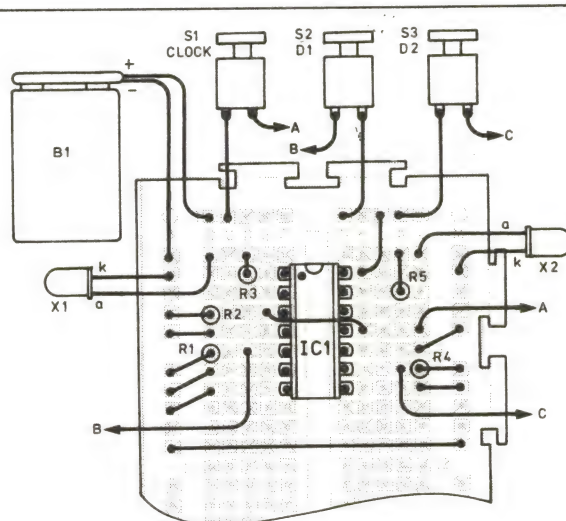


Fig. 13. Layout of the 2-bit D-latch.

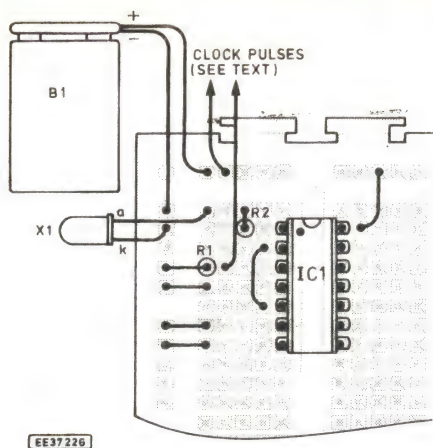


Fig. 15. Construction of the toggling circuit.

divider. This will be examined in more detail presently.

COMING CLEAN

Toggling a bistable may be investigated using the Plugblock layout shown in Fig. 15. No additional components are required.

The main problem with using this circuit is providing the clock pulses. An ordinary push-button switch usually produces several pulses instead of one. This is because the contacts *bounce* as they touch. In view of the great speed at which the bistable can operate, it would toggle on each bounce and the results would be unpredictable. To overcome this, a *debounced* switch is needed.

If a modular kit is being used, then a debounced switch will be provided or "built in" so there should be no problem. In practice, for simple experimental work an ordinary switch may give reasonable results. Sharp and deliberate pressing of the switch helps. It is worth remembering that luck often comes to the aid of the experimenter. Sometimes the switch contacts happen to bounce an even number of times, say 2 or 4, and this achieves the same result as having no bounce at all!

In real systems, a *monostable* is used to provide the clock pulses. An ordinary push-button switch triggers the monostable whose output goes from Logic 0 to 1. This, in turn, provides the clock pulse for the bistable. While it is in the triggered state further pulses due to switch bounce have no effect.

An unconventional method of producing reasonably bounce-free switching may be carried out using a small amount of water in an egg-cup. The clock pulse input wire leading to battery positive is dipped permanently in the water. The wire leading to pin 3 is then dipped in to give a pulse. With practice, this works well. For some reason, a pulse is given as the wire enters and another as it leaves! If using this method, it is necessary to use a higher value of resistor R1 (100k works well).

THE BINARY COUNTER

A binary counter displays the number of pulses fed into it. It consists of a series of interconnected D-type flip-flops each connected in toggle mode (see Fig. 16). Each Q output activates the clock for the next one in line. One bistable is needed for each bit – thus, a 4-bit counter (able to count up to 1111 or 15 in decimal) could be made using 4 flip-flops (or 2 off 4013's).

For ease of construction it is helpful to make a 2-bit counter – that is, one able to count up to 11 (3 in decimal). Again, not very useful in itself but by adding further stages any number may be counted. Fig. 17 shows the Plugblock layout. No additional components are needed to build this circuit. Note that clean clock pulses are once again needed and the water-dipping method described earlier works fairly well.

Refer to Fig. 16; i.e.d's X1 and X2 count units and two's respectively. Imagine an initial state where D1 and D2=1 with Q1=0 and $\overline{Q1}=1$ – X1 is therefore off. Similarly for the second stage, D2=1 with Q2=0 and $\overline{Q2}=1$ – X2 is also off so the count is 0 0. On the first clock pulse, the logic state on D1 (1) is transferred to Q1 (X1 lights) and $\overline{Q1}=0$. This makes D1=0 also.

In the absence of a clock pulse to CK2, nothing yet happens at the second flip-flop and X2 remains off. Thus the count is 0 1. On the second clock pulse, data is transferred from D1 (0) to Q1 so Q1=0 (X1 goes off) and $\overline{Q1}=1$. This makes D1=1 and a clock pulse is also given to CK2. The data is transferred from D2 (1) to Q2 – X2 lights and $\overline{Q2}=0$. This makes D2=0 also. The count is therefore 1 0.

On the next pulse, data is transferred from D1 (1) to Q1 so Q1=1 and X1 lights. The count is therefore 1 1. On a further pulse the cycle would begin again and repeat continuously.

If the above sequence is written down we can see that the device is counting in binary:

Clock pulse	Twos Units (X2)	Decimal Equivalent
0 (start)	0	0
1	0	1
2	1	2
3	1	3

If it is re-written (without the decimal equivalent) but this time extended through a few complete cycles something else emerges:

Clock pulse	X2	X1
0 (start)	0	0
1	0	1
2	1	0
3	1	1
4	0	0
5	0	1
6	1	0
7	1	1
8	0	0
9	0	1
10	1	0
11	1	1
12	0	0

– and so on. Inspection shows that whereas the clock has pulsed 12 times, X1 has pulsed on 6 times and X2 only 3. Thus, we have extended the idea of *frequency division* mentioned earlier. Division by two can be carried out any number of times by using more bistables.

This idea is used in an electronic clock or watch to produce the 1 second pulses for the display. It is easy to produce accurate pulses at very high speed yet it is 1 second pulses which are needed. To solve the problem, pulses are produced at a precise rate of 32,768 per second (32.768kHz) by means of a *crystal controlled oscillator*. This is divided by a string of 15 flip-flops. The first one divides by two to produce 16,384Hz. The next div-

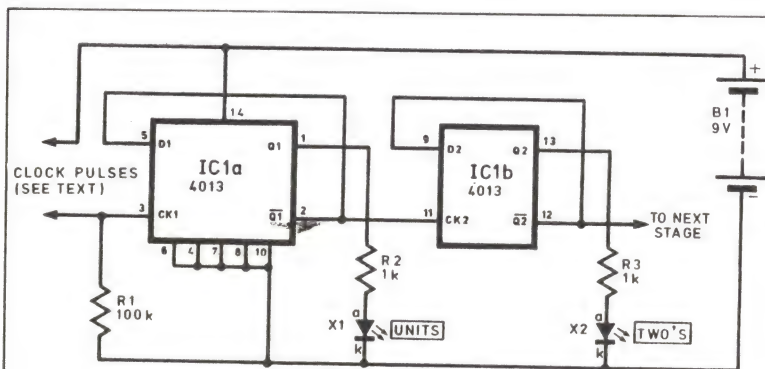
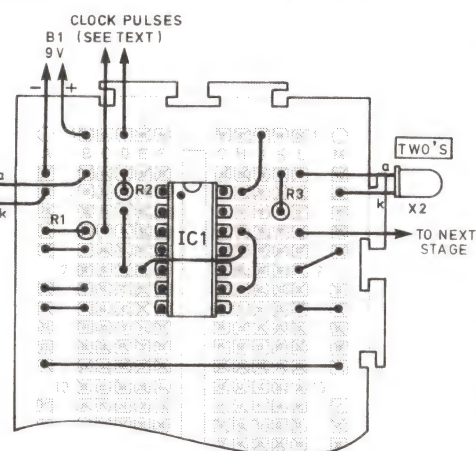
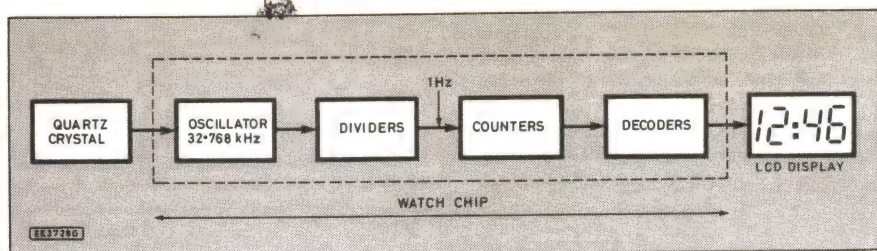


Fig. 16. 2-bit binary counter.

Fig. 17. (right) 2-bit binary counter construction.





The working parts of a digital watch.

ides by two again to give 18,192Hz and so on. After successive divisions, the output of the 15th bistable is 1Hz (check this with a calculator). Of course, if you take the back off a watch you won't find 15 individual flip-flops inside. These are built in a single "dedicated" integrated circuit.

THE SHIFT REGISTER

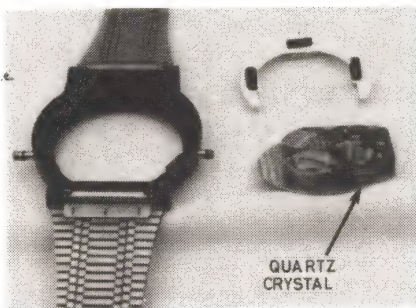
A shift register is another multi-stage D-type flip-flop circuit with each Q output connected to the following D input. The following explanation is for a 4-bit serial shift register. Suppose all four Q outputs are initially at logic 0. When data is fed into input, D1 and a clock pulse given, the data moves along one place.

	Q1	Q2	Q3	Q4
Initial state:	0	0	0	0
If a 1 is fed into D1 the display will be:	1	0	0	0
with a 0 fed in:	0	1	0	0
then a 1:	1	0	1	0
then another 1: and so on.	1	1	0	1

Suppose we wish to send binary data along a telephone line. This is commonly done where information needs to be transferred from one computer to another as in banking or for the operation of a fax machine. Since only one bit at a time can be sent, we could not send the 8-bit binary number:

1 0 1 1 1 0 1 0

all at once unless we had eight separate telephone lines and this would be obviously impractical. Instead, we work sequentially. First, the number is set up in a shift register and when the system is ready, it is clocked repeatedly. The digits move along one step at a time and eventually arrive at the end of the chain,



whereupon they are fed along the line. Some computer printers – so called, *serial* printers – receive their information from the host computer sequentially.

The circuit of a 2-bit shift register is shown in Fig. 18. Suppose a Logic 1 state is applied to D1 by pressing S1 (DATA IN). On the arrival of a clock pulse, this will be transferred to Q1 so X1 lights. This also supplies the data for D2. However, nothing more will happen, until a further clock pulse is given whereupon this logic 1 state will be transferred to Q2. Meanwhile more data can be input to D1. It can be seen that digits move (shift) 1 place to the right with each clock pulse. Eventually, data is lost as it "falls off" the end.

The 2-bit shift register may be constructed using the Plugblock layout shown in Fig. 19. No additional components are needed. It is necessary to apply "clean" pulses to the clock input, Ck1, to avoid the effects of contact bounce. It may otherwise be difficult to trace through the action of each pulse. This may be done using the water-dipping method described previously.

Switch S1 sets the input data – pressing it gives Logic 1 and leaving it released, Logic 0. After building the circuit, connect the battery. Apply clock pulses and check that the data shifts along as it should.

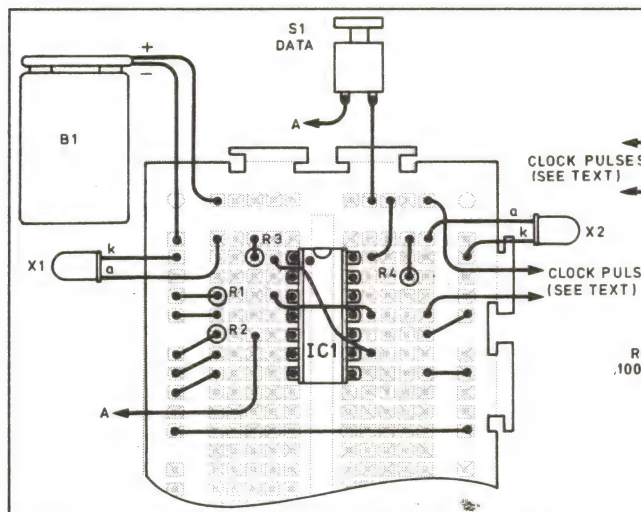


Fig. 19. (left) 2-bit shift register construction.

	COLUMN 1	COLUMN 2	COLUMN 3
ROW 1	FLIP FLOP 1	FLIP FLOP 2	FLIP FLOP 3
ROW 2	FLIP FLOP 4	FLIP FLOP 5	FLIP FLOP 6
ROW 3	FLIP FLOP 7	FLIP FLOP 8	FLIP FLOP 9

Fig. 20. Random access memory illustration.

A 2-bit shift register may not be very useful but by adding further identical stages, any size number may be accommodated.

RANDOM ACCESS MEMORY

Bistables form the basis of computer memory. We have seen that a single flip-flop can remember one binary digit. With sufficient flip-flops we can remember as many bits as we choose. With modern technology many thousands of bistables can be formed on one silicon chip. The memory device called *Random Access Memory* (RAM) enables data to be written (placed) into memory cells and read (retrieved) from them again. The principle of operation is shown in Fig. 20.

For simplicity there are only 9 flip-flops in a 3×3 array. Each flip-flop can be accessed by referring to its row and column. This gives a unique position called its *address*. For example, we could call the second flip-flop in the top row "Row 1 column 2". By referring to the address, we select any flip-flop we choose.

This is what is meant by the rather confusing term *random access*. It is like having a large array of small drawers containing electronic components. If someone wanted a diode you could say "go to the third row, fourth column along". This is the unique address of the diode drawer. A modern RAM i.c. can access a given address and retrieve or place data in a matter of 100 nanoseconds (100 thousand millionths – 0.0000001 – of a second) or less.

That's all for this month. Next time we shall look at the use of IT devices to monitor and control experiments.

IMPORTS **EASY** PC FILES
UPGRADE DISCOUNT AVAILABLE

Finally...an exceptional PCB and Schematic CAD system for every electronics engineer!

BoardMaker 1 is a powerful software tool which provides a convenient and professional method of drawing your schematics and designing your printed circuit boards, in one remarkably easy to use package. Engineers worldwide have discovered that it provides an unparalleled price performance advantage over other PC-based systems.

BoardMaker 1 is exceptionally easy to use - its sensible user interface allows you to use the cursor keys, mouse or direct keyboard commands to start designing a PCB or schematic within about half an hour of opening the box.

HIGHLIGHTS

Hardware:

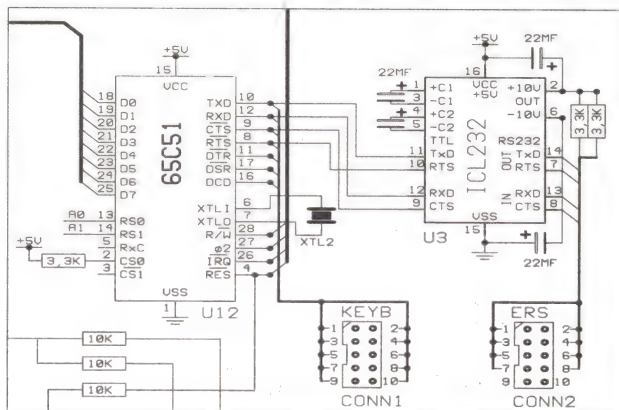
- IBM PC, XT, AT or 100% compatible.
- MSDOS 3.x.
- 640K bytes system memory.
- HGA, CGA, MCGA, EGA or VGA display.
- Microsoft or compatible mouse recommended.

Capabilities:

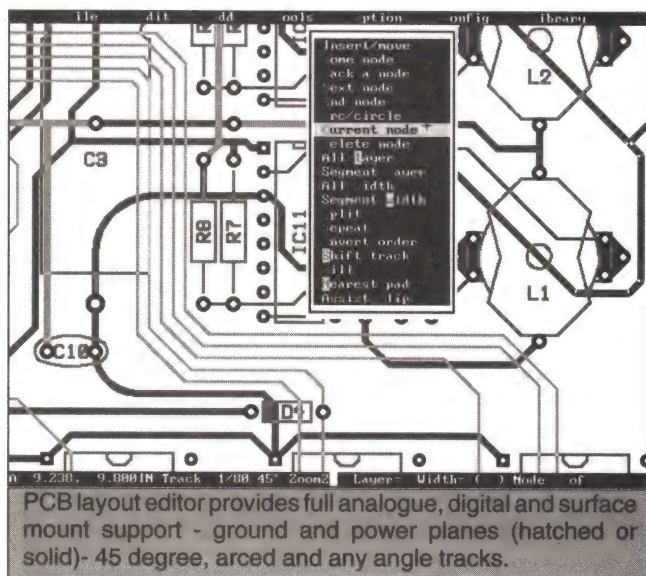
- Integrated PCB and schematic editor.
- 8 tracking layers, 2 silk screen layers.
- Maximum board or schematic size - 17 x 17 inches.
- 2000 components per layout. Symbols can be moved, rotated, repeated and mirrored.
- User definable symbol and macro library facilities including a symbol library editor.
- Graphical library browse facility.
- Design rule checking (DRC) - checks the clearances between items on the board.
- Real-time DRC display - when placing tracks you can see a continuous graphical display of the design rules set.
- Placement grid - Separate visible and snap grid - 7 placement grids in the range 2 thou to 0.1 inch.
- Auto via - vias are automatically placed when you switch layers - layer pairs can be assigned by the user.
- Blocks - groups of tracks, pads, symbols and text can be block manipulated using repeat, move, rotate and mirroring commands. Connectivity can be maintained if required.
- SMD - full surface mount components and facilities are catered for, including the use of the same SMD library symbols on both sides of the board.
- Circles - Arcs and circles up to the maximum board size can be drawn. These can be used to generate rounded track corners.
- Ground plane support - areas of copper can be filled to provide a ground plane or large copper area. This will automatically flow around any existing tracks and pads respecting design rules.

Output drivers:

- Dot matrix printer
- Compensated HP laser printer
- PostScript output.
- Penplotter driver (HPGL or DMPL).
- Photoplot (Gerber) output.
- NC (ASCII Excellon) drill output.



Produce clear, professional schematics for inclusion in your technical documentation.



PCB layout editor provides full analogue, digital and surface mount support - ground and power planes (hatched or solid) - 45 degree, arced and any angle tracks.

£95

Despite its quality and performance, BoardMaker 1 only costs £95.00. Combine this with the 100% buy back discount if you upgrade to BoardMaker 2 or BoardRouter and your investment in Tsien products is assured. Price excludes carriage and VAT.

Don't take our word for it. Call us today for a FREE demonstration disk and judge for yourself.



tsien

Tsien (UK) Limited
Cambridge Research Laboratories
181A Huntingdon Road
Cambridge CB3 0DJ
Tel 0223 277777
Fax 0223 277747

All trade marks acknowledged

MAKING YOUR OWN P.C.B.s



ALAN WINSTANLEY

It's easy if you have the right chemistry

Part Three: Originating your own artwork

THIS part suggests some ways of designing your own printed circuit board artwork, which will appeal especially to those who have invested in the necessary equipment to fabricate boards with the ultra-violet method.

As we said earlier, one benefit of using the UV technique is that all artwork can be retained for future use, perhaps being modified if necessary. Identical boards can also be produced this way in small batch quantities using the same artwork.

Rather than lay an etch-resist pattern directly onto the copper foil of a board, it is much more convenient to prepare artwork on a polyester film where the opaque transfers and crepe paper decals can be altered at will. Utilising existing artwork – such as that given in a project – simply involves tracing the copper track layout onto the film, using the methods described last month. But you might want to create your own track pattern from a circuit diagram, or perhaps convert a stripboard layout to a printed circuit board (p.c.b.).

Guidelines

This month's feature suggests ways of designing your own artwork, and will be of interest to those who do not have the benefit of a computer-aided p.c.b. routing system. Before drafting the artwork, it is worth considering the following aspects of the circuit you are assembling:

1. The physical features of the components used in the circuit. Some parts like transformers may be relatively large or heavy, or might have unusual terminals or mounting requirements.
2. The operating characteristics of both the individual components and the circuit itself – voltages, currents and operating frequencies etc. High voltages and currents (either localised or "global," throughout the circuit) need to be taken into account when deciding the copper track widths and distances from neighbouring tracks.
3. The available space in the cabinet or box housing the p.c.b., which determines the overall size of the board.
4. The need to take various flying leads to or from the board (for indicators, switches, sockets etc.).
5. Any components which become hot in normal operation, e.g. power transistors/heatsinks or resistors. This controls the proximity of any adjacent parts which might be affected by excess heat.
6. The method by which the board is going to be mounted into the enclosure.

In the absence of any other guidelines it is best to start the design of the artwork by defining the above factors, perhaps listing them out for reference.

Neat and Tidy

As far as the size of the board is concerned, one of the enjoyable challenges of designing your own board may actually be to make the p.c.b. as compact and neat as possible, and with practice you will soon become skilled in routing the copper track layout accordingly to limit the size of the card.

Where the size of the board is not critical, it is often preferable to draft the p.c.b. artwork allowing yourself plenty of design space if necessary, and then finalise the board size afterwards before selecting a suitably-sized housing for it from supplier's catalogues (if indeed you are using a box at all). Obviously one has to bear in mind the general sizes (and cost!) of boxes that are available, and not make the p.c.b. impractically large!

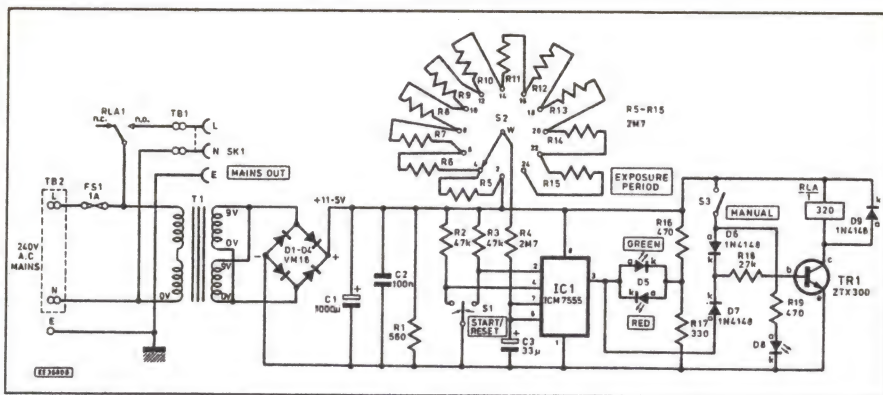
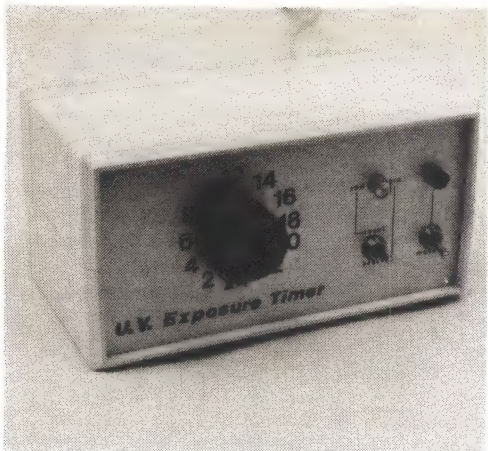
The designer can thus either simply design the copper track layout first, and then make the board the correct size to accommodate it, or alternatively define the size of the board to start with and then try to make the copper track pattern fit it. The latter option may take some skill (and patience), especially with more complicated circuits.

Your initial design brief might also allow for the fact that many plastic boxes (for example) incorporate mounting bushes in their bases so that the p.c.b. can be retained with either self-tapping or machine set screws. No other mounting hardware is generally required in these instances, and the design of the p.c.b. could include the mounting hardware fixing centres, so these would be designed into the artwork to begin with.

Components

Having defined the size of the board the next stage is to consider the circuit and the components themselves, before getting down to the job of designing the copper track pattern itself.

Let's consider an actual design example which will demonstrate the principles of drafting a p.c.b. master artwork from a circuit diagram. A useful accompanying project, *UV Exposure Timer* is described elsewhere in this issue, so the circuit description and constructional details are given in that article. Once the circuit has been designed and finalised, we can



The circuit diagram of the UV Exposure Timer which is used here to demonstrate the approach taken in designing your own p.c.b. A photograph of the completed project is also shown.

specify the basic p.c.b. design in accordance with the above criteria.

It is a very good idea to employ p.c.b.-mounted parts wherever feasible. Often it is possible to build the mains side of the circuit directly on the p.c.b. to reduce any mains interwiring – this makes the project assembly quicker, neater and safer. So when planning the board for the *UV Exposure Timer* we could utilise a p.c.b. transformer (T1) along with the fuseholder FS1 (see article). Both components will fit directly on to the board without any necessary extra hardware being required. The relay too can be a board-mounted type to simplify assembly even more.

Hot Lines

The circuit employs mains and low voltages. In this design the low-voltage side is straightforward though certain circuits (like power amplifiers or heavy duty power supplies) might need extra design considerations to maintain stability and performance. These aspects relate to more advanced designs and will not be discussed further here.

Radio frequency (r.f.) circuits can also have their own quirks, especially when one considers that two adjacent copper tracks can act as an air-spaced capacitor! Alternatively a double-sided board may have an inherent capacitive characteristic when you consider that copper tracks on both sides of the board, separated by the board itself, may give rise to a dielectric effect.

This can unintentionally cause "stray capacitance" around the p.c.b. which could affect the performance of the circuit. Apart from planning the layout carefully, one might also use very thin copper tracks wherever possible to reduce the capacitive effect of the conductors on the circuit. You might see this on an oscilloscope board, for example, where the C.R.O. can operate at very high frequencies (10MHz or more): steps are taken by designers to ensure that the design of the copper tracks does not affect accuracy or performance.

Mains Voltage

In our *UV Exposure Timer* example, a major factor to bear in mind is that a.c. mains voltage is present on the board and is also switched through a relay. It is best to try and group all mains-voltage components into one area rather than disperse them around the board. Also, the tracks which carry mains voltage *must* be of adequate thickness to carry the peak current safely. The rest of the circuit is at a low voltage and the design of the p.c.b. tracks in that area should be straightforward.

Having pondered the operating characteristics of the circuit, the next criterion in our list relates to the space available in the housing used to accommodate the finished board. In fact, the author opted to select the (plastic) box first and design the p.c.b. to fit it and so the dimensions of the board were finalised at 110mm x 68mm. The plastic box used (see parts list) is also high enough to accept the highest component on the p.c.b., namely the mains transformer.

Also we need to consider the flying leads which we wish to take from the board and hook up to external switches, indicators etc. Two sets of mains-voltage flying leads will be utilised – live (L) and neutral (N) mains input, and also live and neutral mains output to the outlet socket. The safest way to connect mains leads to the board is via p.c.b.-mounting screw

terminal blocks, so two two-way terminals will be required.

All other flying leads for the switches and indicators are at low voltage and these can be soldered directly to the p.c.b. More elaborate designs might use pin headers and sockets so that flying leads can be plugged into the board, making it easy to disconnect them to remove the board for servicing or repair.

None of the components in this design get unduly hot during operation, so we do not need to worry about leaving ample space for a heatsink.

The final specification for our board relates to the mounting hardware for the board. The plastic box chosen does not have any mounting bushes moulded in the base, so the board will be mounted firmly with nylon screws, nuts and stand-off pillars. We need to remember to incorporate mounting holes in the p.c.b., therefore.

Light Work

Having outlined the main p.c.b. design parameters let's now look at the process of preparing the artwork itself.

This is best drafted onto polyester film, which is translucent and tear-resistant. Other media which could be used included transparent acetate film (such as overhead projector film) but some types are liable to rip very easily, destroying the artwork with it!

The job of drawing up the artwork is made considerably easier by using a light-box, especially when dealing with more complex designs involving integrated circuits. Light-boxes have a translucent surface and are illuminated from inside with fluorescent tubes. Using a light box enables you to superimpose electronic component arrangements onto copper track layout artwork so that you can design the p.c.b. on paper and see the copper tracks underneath through the component layout.

Thus, with a light-box, you can juggle both the component layout and the copper track design around, and see one side of the board in relation to the other. A light-box also obviously illuminates the work while you draft it and makes the artwork easier to see!

It is relatively simple to make a fluorescent light box from readily-available materials (e.g. Conti Board and Perspex) and the author designs all his artwork on the light console which will be described next month. The design utilises a Thorn "2D" compact fluorescent tube which fits a standard bayonet (BC) light socket and requires no external starting or control gear. The box also has a sloping front making it easier to use when sat at a desk.

Starting Grid

Many components such as transformers, relays and integrated circuits have their terminals arranged on a regular grid, and generally – but not always – a 0.1in. matrix "pitch" (distance between the lines on the grid) is employed. It is obviously necessary to make sure that the holes drilled in our p.c.b. have a pitch which matches the terminals of the components if the parts are to fit the board properly.

It is possible to buy an accurate 0.1in. pitch grid printed like graph paper onto polyester film, which helps to gauge distances between terminals when designing the artwork. (The grid is often included in packs of plain polyester drafting film). It is best to tape this grid using Scotch Magic Tape to the light box

to enable the designer to accurately align components onto a 0.1in pitch.

The next step is to try and determine the best arrangement of the components on the board, and it often helps if at least the major parts (large transformers, relays etc.) are to hand so that the designer can visualise the arrangement of the components. Using a pencil and paper, draw out an approximate actual size layout of the components to get an idea of how the parts can best fit together.

You will probably need to change the layout around as the artwork evolves. Bear in mind the specification we drew up earlier, so that hot components are not too close to other parts, mains-voltage parts are all grouped together where possible, etc.

Board Room

At this stage the author uses the light box to see through the paper, and by turning over the paper it is possible to draw in with pencil on the reverse, a rough copper track layout which will link up the components in accordance with the circuit diagram. If a copper track cannot be routed because it is blocked

by existing copper tracks, use jumper link wires to bridge over the obstruction.

When the paper is viewed on the light box, a see-through view is obtained so that it is possible to see the rough copper track layout, like an X-Ray, in relation to the components.

There are no hard and fast rules regarding the best way of drafting out a rough layout, and you may wish to use tracing paper for both the parts arrangement and the copper track layout. View them in alignment with each other to realise the overall artwork design. Whichever method you adopt, the use of a light box will certainly make the job a lot easier.

Eventually, after some trial and error (a lot, on complex boards!) you will have a rough draft of how the parts are to be arranged on the p.c.b. and also how the copper track pattern is to be designed. The next stage is to translate this into actual artwork, ready for exposure using the ultra-violet system.

Place a fresh piece of polyester drafting film, cut to a suitable size and leaving a generous margin, over the 0.1in. pitch grid on the light box, and tape it down with Scotch Magic Tape. Ensure the film is completely flat against the light box.

Using your rough pencil copy as a guide, commence the



Photo 1. Designing your own artwork starts by drafting a rough component layout diagram, referring to the circuit diagram and manufacturer's data as required. Here, the EE Light Box (next month) is being used, which proves invaluable in the following stages.

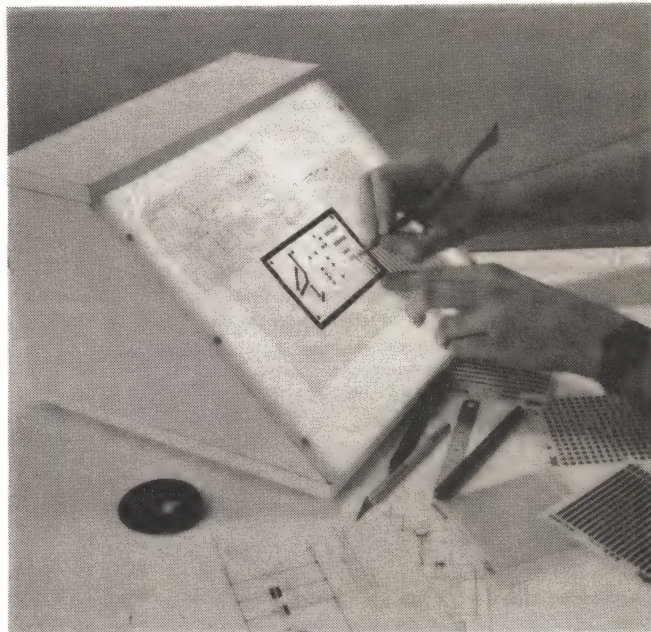


Photo 2. Starting to prepare the master artwork using Alfac rub-down transfers. Also on the Light Box is the author's rough draft – the proposed copper track layout shows through the paper so that an "X-Ray" view of the rough version is seen.



Photo 3. The completed artwork on the light box – the precision 0.1in. matrix grid is also visible. This view is actually equivalent to seeing the copper track pattern "through" the board from the component side.

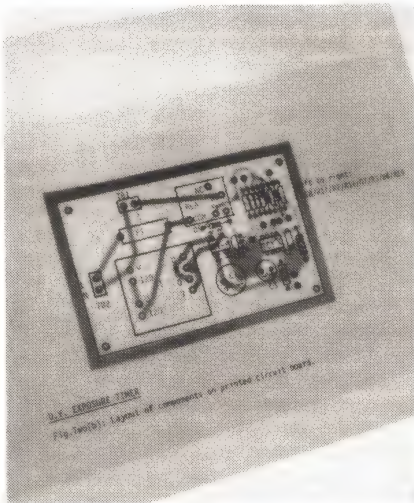


Photo 4. The artwork with the finalised component layout superimposed on it. This stage can be used for double-checking your copper track design for errors or omissions.



Photo 5. The artwork is turned over and clearly labelled "Copper Track View Side" – this is your first sight of the actual copper foil pattern which will be etched into your p.c.b.!

preparation of the artwork by placing down the mounting pads of the components, using either crepe tape circles or rub-down dry transfers of appropriate diameter. Use the same technique as described earlier (May '92 issue - Supplement) in the "Direct Etch" method of p.c.b. production.

Large circles (roughly 3.6mm outside diameter (o/d) or more) are best for mains components and terminals. For general purpose pads 2.4mm o/d are quite adequate and again special shapes are available for integrated circuit pin-outs which are already conveniently laid out on the correct 0.1in. pitch. Lay down all pads on the intersections of the 0.1in. matrix so that they match the pinouts of the various components used.

Trim the pads if necessary with a scalpel to prevent them touching any neighbouring pads or tracks. You will see that several large pads have been trimmed for this reason on our working example layout for the *UV Exposure Timer*.

Some components are manufactured on a metric grid, often showing up in data as a distance of 5.00mm between pins. An equivalent part in a true imperial pitch of 0.1in. would be shown as 5.08mm distance in catalogues. The two parts are not always interchangeable: the small difference of 0.08mm can give rise to a cumulative error which could mean that a metric pitch part will not necessarily fit a 0.1in. pitch p.c.b., and vice versa.

Where a metric pitch part is used (certain mains transformers, for instance), the 0.1in. grid taped to the light box will have to be ignored if the metric component is to fit the board correctly.

Making Tracks

Next, start to interlink the pads with either crepe tape or dry transfer lines, using the relevant thicknesses as necessary. Looking at the artwork for the *UV Exposure Timer*, it will be seen that all mains parts are at one end of the board, with 240V connections via screw terminals for safety.

The mains-voltage tracks need to be of adequate thickness. As a rule of thumb, the author designs these mains-voltage tracks in 2.5mm wide section (which is good for up to 5 Amps at 250V in 1oz. copper foil), and separates them by a distance of 1.5mm to 2mm minimum where possible. Extreme care is needed not to space the tracks so closely together that any high voltages flash over between tracks can occur.

The primary and secondary windings of the transformer have been interlinked as shown in the circuit diagram, such that the twin 120V primary windings are in series, making the transformer suitable for domestic 240V mains operation. The two secondary windings are in PARALLEL (both 0V terminals joined together, and both 9V pins similarly linked.)

It is absolutely vital that the transformer is wired correctly to avoid any unpleasant occurrences! Double check with supplier's data and look at the part itself to confirm the pinouts. There appears to be no standard pinouts for p.c.b. mounting transformers and different manufacturers each have their own style.

Likewise double check the bridge rectifier connections and the smoothing capacitor C1 for polarity, as there is no standard arrangement. Reversed polarities here could prove dangerous. Again, supplier's catalogues will be of help when determining distances and pinouts.

It is often a good idea to make the positive and negative power supply conductors as thick as possible to avoid any noise or ripple being induced on the power supply lines when thin conductors could create an unwanted electrical resistance. One may also need to consider high switch-on surges amongst other factors, the effects of which will be reduced by keeping the power supply tracks as thick as practicable. It is not critical in this design, where supply requirements are not very demanding, but it is not a bad habit to use wide (say 2.5mm) track for main power conductors, even though they are at low current.

The rest of the copper track layout is really a matter of translating one's rough pencil sketches onto the polyester film using more opaque transfers. The rest of the *UV Exposure Timer* artwork is quite straightforward and uses 1.00mm or 0.8mm wide lines for most of the low-voltage component interconnections. You can be as elaborate as you like and you will doubtless develop your own style.

Retouching

The ultra-violet process method will reproduce any flaws in the artwork, so it is necessary to ensure that there are no breaks

in the conductor lines etc. Any faults can be touched up using more transfers laid on top.

Any pads or tracks which are laid down in error can often be removed by laying some sticky tape over the offending area, and pulling away sharply. The transfers will often come away with the adhesive tape. Alternatively, the transfers can be scraped away with a scalpel.

It will be seen on the example artwork that there are several relatively large areas of copper. These can be drafted by outlining the area with tape or transfer lines, and then painting in the central area with matt black enamel paint; or, fill in the middle by laying down wide transfer lines, slightly overlapping each other and cut to shape with a scalpel.

It must be borne in mind that more copper equates to more adhesive holding the copper foil onto the glass fibre panel. Extremely thin tracks and very small pads are not able to withstand much heat when soldering and may lift off. (Tips were given in Part Two about repairing the board under these circumstances). By laying down larger areas of copper track, you will not only make the copper foil pattern better able to adhere to the board, but you will speed up the etching time also.

Component View

When eventually the artwork has been drafted, you will finish up with a "see-through" view of the copper track pattern, as seen through the board from the component side. The next thing to do whilst it is still taped to the light box is to draw up a component layout diagram, actual size. Lay a piece of paper over the artwork and draw on the actual positions of the components, showing the locations of all pinouts and terminals clearly.

Also label the components on your drawing as per your circuit diagram and retain for future reference. At this stage, you will have drawn both the copper track layout and have separately superimposed the component layout onto it: you can now *double* check your work thoroughly.

Look especially for incorrect or reversed connections to integrated circuits, transistors etc. A mistake spotted now can be rectified on the polyester film, but once you have committed your design to the board, it could be difficult or impossible to effect any corrections. **Check carefully!**

On the Right Side

Now remove the artwork from the light box and *turn it over*. You will now be looking at the actual design which is to be etched into the copper foil.

It is strongly recommended that you put an adhesive label on this side of the artwork in the margins and mark it with the title of the project, date etc. and very clearly mark words to the effect of "*this side copper track view/this side to UV light*" or similar. You can, incidentally, also add rub-down lettering such as the name of the board in the layout, on this side of the artwork and it will appear (the right way round!) on the copper foil layout of your board.

You are now only interested in the labelled side of the artwork, i.e. the side on which you did NOT apply any layout transfers. This view represents the *actual* foil pattern layout and is the side which will be placed down against the UV light source. The sensitised board - which is cut to size to fit the artwork - will be placed on top of it. The board can then be exposed and processed as normal using the techniques described in previous months.

When you have finished with the artwork, it can be stored in a stiff envelope or a file, along with the component layout diagram, so that it can be modified or re-used at a later date. Take care when handling the artwork as the rub-down dry transfers of the artwork are liable to be damaged by scratching.

Designing your own printed circuit board from scratch and then fabricating it from just a plain board can be a very rewarding experience. This series has shown the constructor the various techniques for both originating artwork and producing your printed circuit boards at home. The reader will certainly benefit from experimenting to develop his own preferred methods - have fun!

Next Month: The construction of a simple Artwork Light-Box will round off this short series.

UV EXPOSURE TIMER

ALAN WINSTANLEY

You will only obtain consistent results if your "light sensitive" p.c.b. receives the right exposure. Covers a time period of 2 to 24 minutes in two minute steps.

WHEN producing printed circuit boards (p.c.b.s) with the more advanced ultra-violet processing system, it is necessary to expose a sensitised board to a UV light source through the artwork positive.

Exposing the board for too long a period will rarely cause any damage, but troublesome problems can be caused by *under-exposure*, when the UV sensitive coating will not have thoroughly reacted to the UV light. This will only become apparent when you try to develop the board, because it will be impossible to remove all of the unwanted resist coating. The surface of the etch-resist ink might wash off in the developer but a layer of ink can still be left on the board, because the UV light has not had enough time to penetrate all the way through the resist.

Under these circumstances, all you can do is to try to re-align the board on the artwork and expose it for a further period, but you may well have to scrap that attempt and start again with a freshly-coated board. Further information is given in the "Making Your Own Printed Circuit Boards" series.

MAKING TIME

In order to obtain consistent results, it is best to expose the board for a timed period, though only the more expensive UV Light Boxes have a built-in timer.

The UV Exposure Timer described here enables the constructor to operate an ordinary UV Light Unit for a predetermined period (from 2 to 24 minutes, in two-minute steps) and will then automatically turn off. You can use this time to prepare the developer, etchant etc., or carry out any other tasks.

Using the timer also means that you can experiment to optimise the exposure times with different makes of sensitised boards and not worry about under- or over-exposure. You will certainly need to experiment with exposure periods if you are coating your own boards with a UV sensitive aerosol lacquer.

CIRCUIT DESCRIPTION

The full circuit diagram for the UV Exposure Timer is given in Fig. 1 and is seen to be based around a simple 555 timer

chip IC1, wired as a monostable. The time period is determined by the resistor network R5 to R15 which are switched through S2.

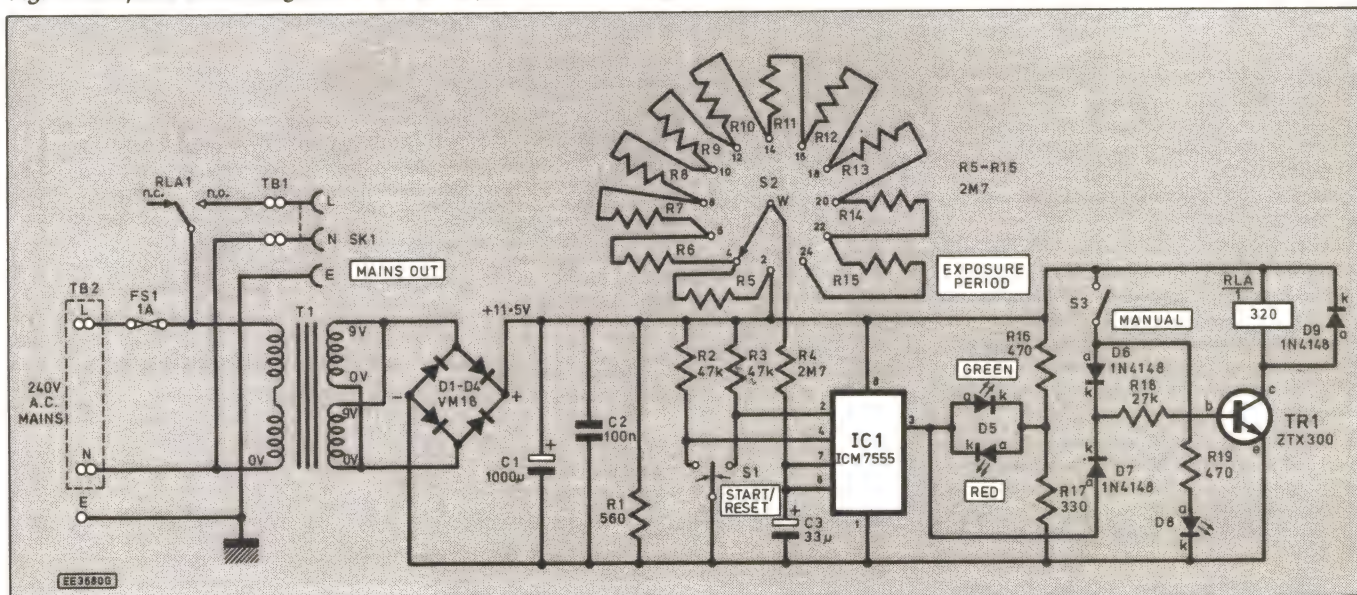
Rotating the switch S2 increments the monostable period by almost exactly two minutes, as measured on the prototype. The unit generates delays of between 2 and 24 minutes, which should cover every eventuality.

Since the 555 timer IC1 can be both triggered and reset by grounding pins 2 and 4 respectively, these functions have been combined into one control S1, a single-pole biased centre-off toggle. When IC1 is enabled, the output at pin 3 goes high, the l.e.d. D5 glows green and changes back to red when the period is up.

The 555 also drives a mains relay RLA through the transistor buffer TR1. The relay contacts RLA1 switch on the UV Exposure Light Unit, which is connected to the timer via the miniature mains socket SK1. It is possible to manually operate the UV "Light Box" by operating switch S3, which completes the circuit to the relay coil and also illuminates D8.

The whole circuit is driven by a simple mains power supply and associated components. The circuit is fused, along with the mains load connected to SK1, by a 1A quick-blow fuse FS1.

Fig. 1. Complete circuit diagram for the UV Exposure Timer. A Light-Box is connected to the timer via the "Mains Out" socket SK1.



CONSTRUCTION

In order to simplify construction, nearly all parts are mounted on a single-sided glassfibre printed circuit board, measuring 110mm x 68mm. This board can be purchased from the *EE PCB Service* code EE792, but you might want to make it yourself! The actual design of the p.c.b. artwork is discussed in Part 3 of "Making Your Own Printed Circuit Boards" and may be of interest to the constructor.

The 1:1 (full size) artwork positive of the underside copper foil master pattern and topside component layout is shown in Fig. 2. It can be seen that all the mains parts, except socket SK1, are mounted on the board which greatly simplifies the interwiring, also making the unit that much more reliable.

Both the mains transformer and the relay MUST possess pinouts which match the p.c.b., and only the specified components (see *Shoptalk*) should be used in

COMPONENTS

Resistors

R1	560 $\frac{1}{2}$ W
R2, R3	47k (2 off)
R4 to R15	2M7 (12 off)
R16	470
R17	330
R18	27k
R19	470

All 0.25W 5% carbon film except R1.

Capacitors

C1	1000 μ radial elect. 25V
C2	100n polyester
C3	33 μ radial elect. 16V

Semiconductors

D1-D4	VM18 100V 0.9A d.i.l. style bridge rectifier
D5	5mm bi-colour l.e.d.
D6, D7	1N4148 signal diode (2 off)
D8	5mm red l.e.d.
D9	1N4148 signal diode
TR1	ZTX300 npn silicon
IC1	NE555V or ICM7555 timer i.c.

Miscellaneous

T1	p.c.b. mounting transformer, twin 120V primaries, 0V-9V, 0V-9V secondaries 6VA total
RLA	min. mains relay s.p.c.o. 3A a.c., 320 ohm 12V coil
FS1	20mm p.c.b. mounting fuseholder with 1A quick blow fuse
S1	s.p.c.o. miniature toggle switch biased both ways to centre off
S2	Single-pole 12-way rotary switch
S3	s.p.s.t. min. toggle switch
SK1	Euro-style miniature panel mounting mains safety socket

Case, Vero Apollo S3 beige, size 155mm x 79mm x 91mm; mains rated, p.c.b. mounting, 2-way screw terminal block (2 off); 8-pin d.i.l. socket; l.e.d. lens clip, one each-transparent and red; 6A 3-core mains cable; cable retention gland; 6A connecting wire; single-core connecting wire; p.c.b. mounting hardware; pointer knob; solder etc.

Printed circuit board available from *EE PCB Service*, code EE792.

Approx cost
guidance only

£20

excluding case



CASE AND INTERWIRING

The p.c.b. was designed to fit an instrument box measuring 155mm x 79mm x 91mm which has a clip-together plastic top and bottom with drop-in aluminium front and rear panels. The board is secured to the base section with M3 mounting hardware.

The front panel carries the switches, and the timing resistors are soldered directly to the tags of the rotary switch S2 as shown in Fig. 3. The two light-

this respect. Other parts may not fit the p.c.b. artwork given, though the constructor making his own board can easily adapt the artwork to accept any components which he has available, provided that the electrical characteristics match those specified.

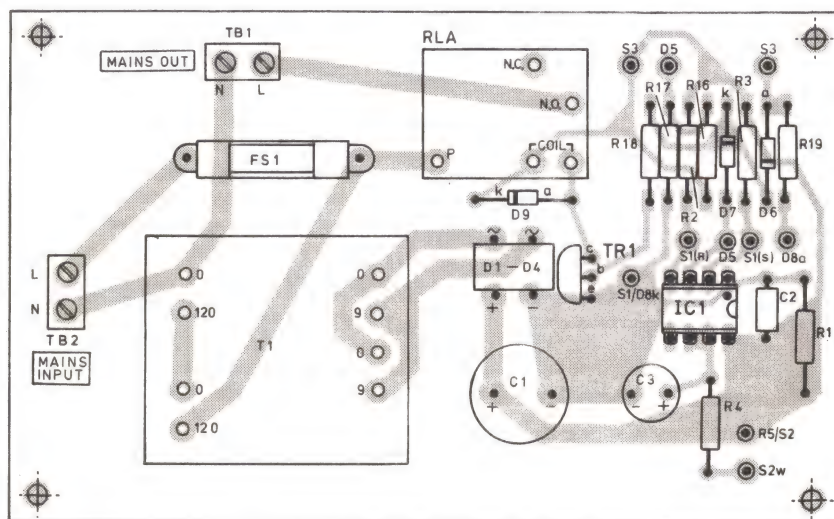
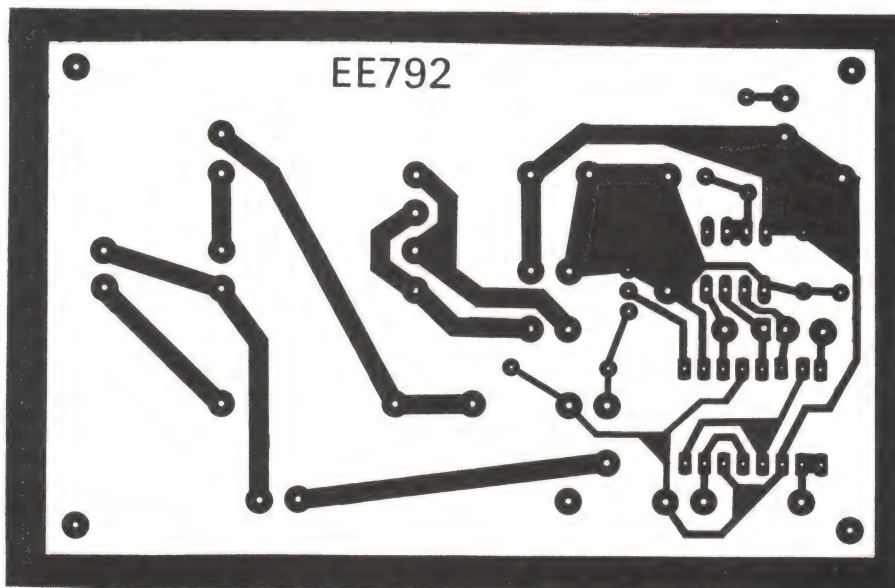


Fig. 2. Printed circuit board component layout and full size copper foil master pattern.



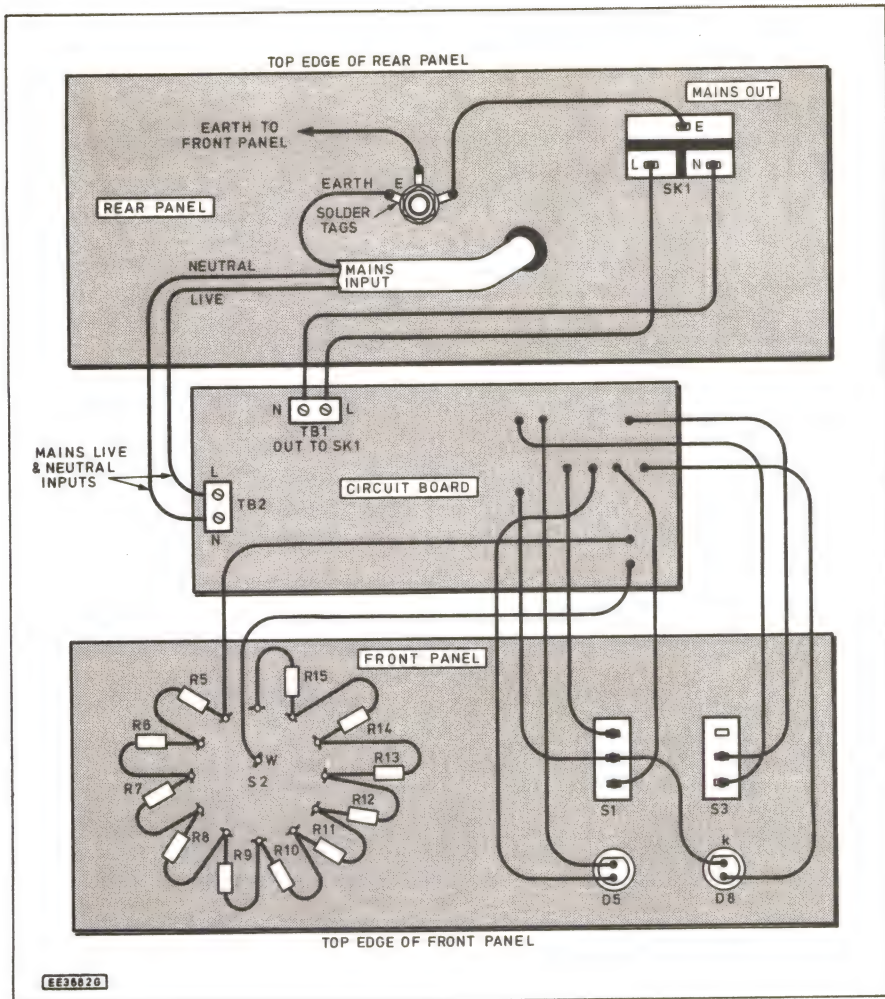
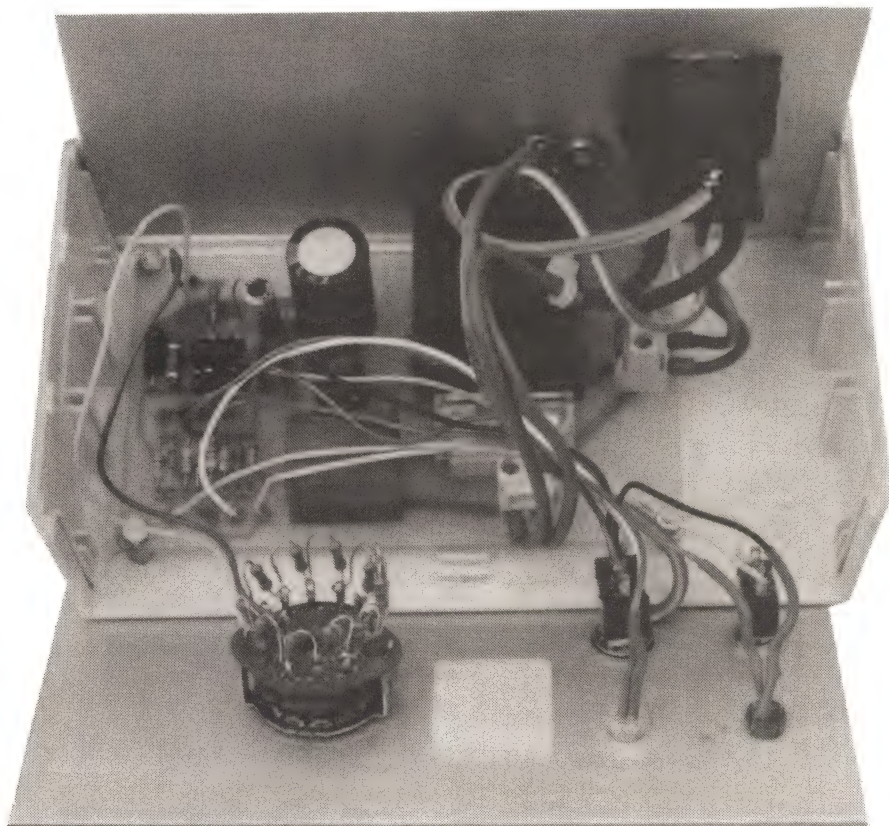


Fig. 3. Interwiring from the circuit board to the front and rear panels. The Earth lead from the rear panel solder tag to the front panel can be "earthed" under either switch S1 or S3 mounting washer. The completed unit showing layout of components inside the case is shown below. Where the mains leads are soldered to the output socket SK1 the solder joints and tags should be covered with plastic sleeving.



emitting diodes D5 and D8 require either mounting bushes or lens-clips. The bi-colour l.e.d. can utilise a transparent lens-clip to good effect. You may wish to embellish the controls with rub-down lettering followed by a coat of spray-on protective lacquer as usual.

The interwiring is generally straightforward and is completed with general purpose hook-up wire. Six amp three-core mains flex is used for the mains input which connects straight to the p.c.b. You can, if you wish, for added safety wire an illuminated, double-pole, mains rocker or rotary switch between terminal block TB2 and the mains lead. The switch can be mounted on the front panel and will show when the unit is powered-up. The front and rear metal panels **MUST** be soundly Earthed as shown. A series of solder-tags is connected together with a countersunk mounting screw on the rear panel. The screws used for p.c.b. mounting must be nylon as they pass through the plastic case.

The mains output socket SK1 is a Euro-style snap-in type which is fitted into a suitable cutout on the rear panel. The mains inlet cable must be secured to prevent it from pulling out, and a cable gland or "P" clip can be used as normal.

TESTING

When all construction has been completed in accordance with the diagrams, check all interwiring etc. carefully, set the rotary switch to "2 Minutes" and then power up the unit. The bi-colour l.e.d. D5 should glow red ("Reset" mode) and operating switch S1 to "Start" should change D5 to green and the relay should be heard to click in.

After the selected delay the relay will click out and the bi-colour l.e.d. D5 will revert to red. Finally, check that the "Reset" S1 and "Manual" S3 functions operate and the unit is then ready for use. The UV Light Unit is connected to the Timer with a miniature 3-pin plug to match SK1.

MAINS SUPPRESSION

The author's UV Light Unit contains two fluorescent tubes along with the usual control gear. It was occasionally found in practice that the timer would re-trigger when the light tubes were switched off when the timer timed-out, presumably caused by a switch-off "spike" on the supply.

The result is that the relay RLA is heard to click at the end of the timing period, but the timer re-starts as it is caused to re-commence timing for a further period.

This problem was entirely eliminated by adding a suitable R/C suppressor between the Light Unit and the Timer. A standard delta-capacitor type device was used which has a built-in inductor and bleeder resistor (Roxburgh suppressor type SDC051, rated 250V 5A).

In fact, since there was no room within the timer box to add the filter, a separate plug-in suppressor unit was built, which has the output wired to a miniature plug to mate with SK1: the unit has a 13A flush mounting socket into which the UV Light Unit is plugged. It is very simple therefore to plug the suppressor in-line.

Readers can determine whether or not any extra suppression is required with some simple usage tests, as it may not be necessary to go to the added expense of incorporating any spike suppressors, depending on the characteristics of the light unit used. □

EVERYDAY NEWS

BUGGING THE TRUCK

Satellite communications are getting more versatile. And growing: BT's big ground station at Goonhilly Downs in Cornwall is just one of a number. A terminal in London's Docklands now carries 41 TV channels to Europe.

The early analogue systems are giving way to more powerful digital ones. These can cater for the smaller user. The range of services already includes automatic telephones for commercial passenger aircraft. Under a new development contract BT will extend this Skyphone service to include fax, probably next year. Such developments are aided by the possibility of using small omnidirectional aerials compatible with airframe structures. Another likely development will be a global paging system.

Costs fallen

The concept of the *Inmarsat* marine communications facility, designed for commercial ship use, has now been extended to embrace smaller vessels such as yachts. The necessary aerials are a fraction of the original size and costs have fallen too. But why stop at aircraft and shipping? Land vehicles could also benefit from satcom links.

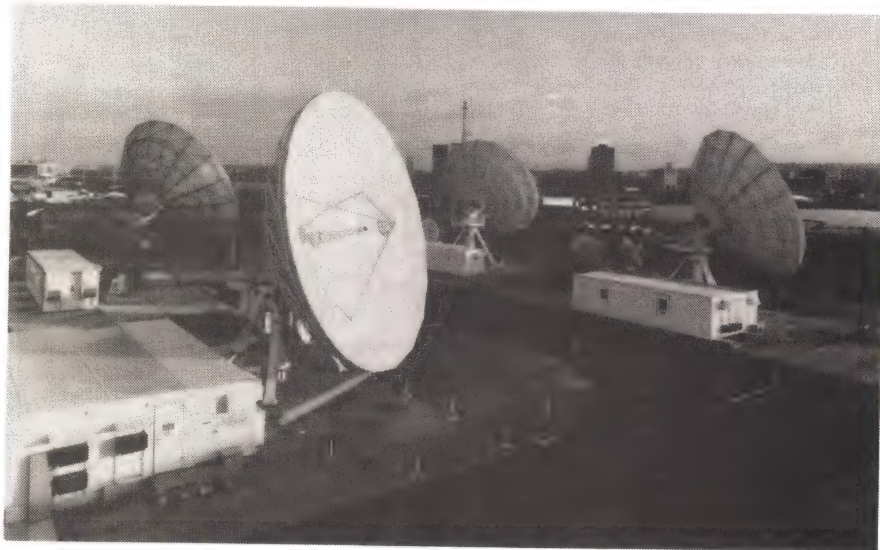
A promising type of customer is the trucking fleet operator. Satcoms

based on modern digital satellites like *C-Sat* could provide affordable data links. Even a one-way (headquarters to driver) link could deliver money-saving changes of schedule to the driver. A

two-way link could be revolutionary. By also fitting the truck with a receiver for the GPS global position-finding system its whereabouts could be monitored automatically at base, with an accuracy of 100 metres. BT is currently carrying out a survey of customers' needs.

In the USA a truck system has already performed a feat comparable with the arrest, in the earlier days of radio, of the murderer Dr. Crippen in an Atlantic liner as the result of a Morse message. A hijacked truck's progress was mapped. When it stopped in a remote area police pounced and arrested the robbers as they off-loaded the cargo.

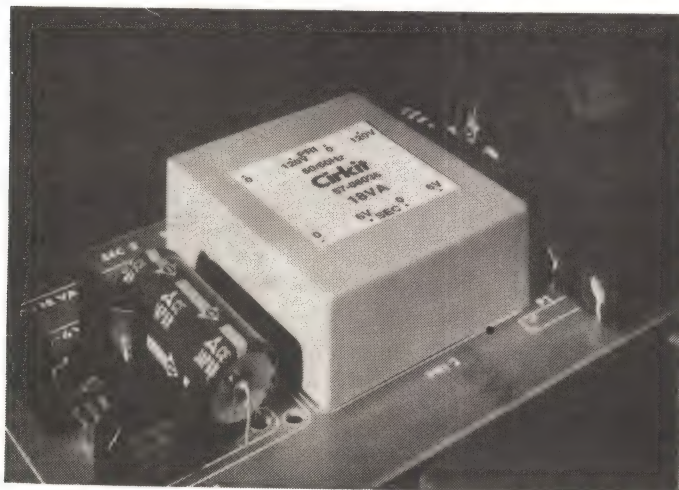
Future hijackers may be smart enough to disable the satcom link



London Teleport reaching 20 million people in Europe.

Low Profile Transformer

A new range of encapsulated low profile mains transformers are now available from Cirkit. These high quality, p.c.b. mounting transformers are ideal for applications where space is at a premium, the 6VA size, for example, is only 44 x 52 x 22mm. Independent primary windings allow 120 or 240V 50/60Hz operation, together with independent secondaries which may be connected for series, parallel or centre tap operation, giving a wide choice of voltage/current combinations.



Wound on twin double section bobbins to provide maximum isolation - 4kV - between windings and near toroidal characteristics.

Cirkit Distribution Ltd., Dept EE, Park Lane, Broxbourne, Hertfordshire EN10 7NQ. Tel. 0992 441306, Fax. 0992 464457.

but simply knowing where and when it happens could be a useful clue. Less exciting but profitable uses could be re-direction of the driver to alternative delivery points and early warnings of temperature rise in refrigerated cargoes.

Efficient use of *C-Sat* is ensured by a message store-and-forward system. When the satellite is busy messages queue up and are sent out at a steady rate. Delays are unlikely to exceed a few minutes while capacity is maximised. By using low data rates (600 bits/sec) the mobile aerial can be compact and omnidirectional.

The huge dishes at the BT ground stations don't seem to change much over the years. But the technology behind them does. The front end receiving amplifiers were once elaborate parametric or maser types which were cooled to very low temperatures (to reduce noise) by elaborate cryogenic refrigeration systems. Now they are simple GAs-f.e.t.s, equipped with compact Peltier coolers which reduce temperature to the required 80-100°K.

SHARP APPLES

One of Japan's leading electronics companies, Sharp Corporation, has announced a long-term agreement with Apple Computer Inc. of America for the development, manufacture and distribution of the next generation personal information equipment.

Apple Computer, Inc. in the States is claimed to be the world leading computer manufacturer and, in January 1992, they advocated a prospect and development for "PDA (Personal Digital Assistant)" information devices of a new category which would bridge a gap between the current personal computers and consumers electronics.

Sharp is claimed to be leading the world in the area of development and production of individual/home information tools and plans development and exploitation of "the next-generation of products based on their 'Personal Information Tool' initiative which advocates considering communication among people and copossession of information going beyond the conventional personal idea and creating a new life culture." - Their words not ours!

FM BREAKTHROUGH

A new method of decoding narrow band f.m. signals has recently been announced by Ampsys Ltd., a small spin off company of Paisley College. This patented technique removes the spikes (or spurs) from the radio signal just as the link is breaking down and also provides inaudible squelching. These two effects, it is claimed, greatly reduce listener fatigue especially over sustained periods. Other advantages include a 25 per cent increase in usable range for any f.m. PMR and/or a reduction of fifty per cent transmitted power for the same reception range.

A further improvement is that co-channel interference is reduced and two f.m. channels on the same centre frequency can now be decoded without mutual destruction. The circuitry is currently under evaluation by a number of multinationals. The new decoder uses an amplitude locked loop in combination with a phase locked loop to achieve this breakthrough.

Dry Cell Recharger

Our *Dry Cell Recharger* project back in the September '91 issue stirred up plenty of interest amongst readers and the national press. Quite a few readers have asked if such an item is available commercially and we are pleased to report that a unit is being pilot marketed by Coltronics Systems. Their Dry Cell Recharger will charge AA, C, D, and PP3 batteries. It will recharge Ni Cad, Zinc-Chloride and Alkaline cells. During one complete charge cycle of 96 hours the charger consumes approximately 1 1/2p worth of electricity, so it is not expensive to run.

The act of charging any battery causes a chemical reaction inside the cell, restoring battery voltage and capacity, with excess energy being dissipated as heat. Overheating degrades battery electrolyte, and rechargeable types are designed to cope with this to a large extent, but dry cells are not.

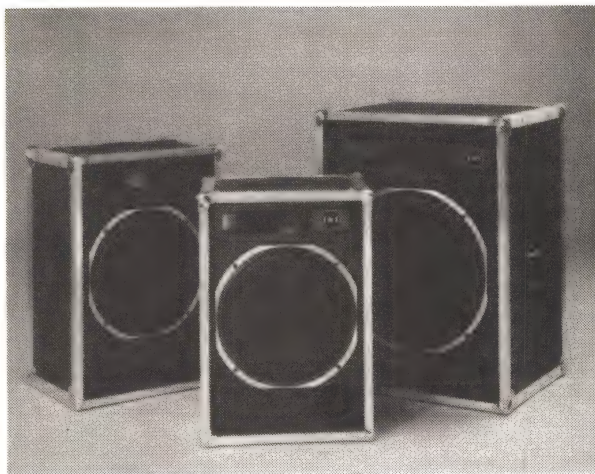
Any attempt to charge dry cells with conventional battery chargers causes severe electrolyte degradation, eventually shorting out the cell completely and leading to a very rapid heat build up inside the cell. Consequently, dry cell manufacturers, quite rightly, put warnings on their products as such abuse can lead to the cell rupturing and electrolyte leakage.

The Coltronics charger avoids these problems, employing state-of-the-art electronics to carefully control and profile the charging current to eliminate heat build up and minimise electrolyte degradation.

We should say that this is a more sophisticated design than the simple unit we published and is available by mail order for an inclusive price of £39.95. This price includes adapters, which incorporate dedicated circuitry, for the four sizes of battery.

Coltronics Systems Ltd., are at Dept EE, 47 Hardwick Industrial Estate, Bury St. Edmunds, Suffolk, IP33 2QH. Tel. 0284 755600, Fax. 0284 753299.

Speak Up



Three flight cased loudspeakers made by IBL are now available in the UK via B.K. Electronics. The full range are: 12" 100 Watts rms; 12" 200 Watts r.m.s. and 15" 200 Watts r.m.s. All models are fitted with wide dispersion horns and include grilles, factory-fitted to the die-cast aluminium loudspeaker chassis. These models are priced respectively at £159.00, £175.00 and £229.00 per pair, including V.A.T. Delivery, via a specialist carrier, is charged at £12.50. **B.K. Electronics** are at Dept Ee, Units 1 and 5 Comet Way, Southend-On-sea, Essex. SS2 6TR. Telephone: 0702 527572 Facsimile: 0702 420243.

NEW FACE OF C&G

City and Guild's *Information Technology* (7261) scheme, first launched in 1985, now boasts 55 modules in subjects ranging from Coding and Programming in 'C', Program Design Techniques and Data Processing, through Microcomputer Business Applications, Computer-aided Graphics and Desktop Publishing, to Digital Electronics, Analogue Circuits and Fault Diagnosis and Microcomputer Systems Installation and Maintenance.

Many of the modules have been extensively revised and updated, and further development and revision work on other modules is continuing.

New diplomas and certificates, made up of particular groupings of 7261 modules, are now available as listed below. These groupings have TEED (the Employment Department's Training, Enterprise and Education Directorate) approval as VQs, and are accepted as being equivalent to NVQs at levels 1, 2 and 3.

Certificate, Diploma, Advanced Diploma in:

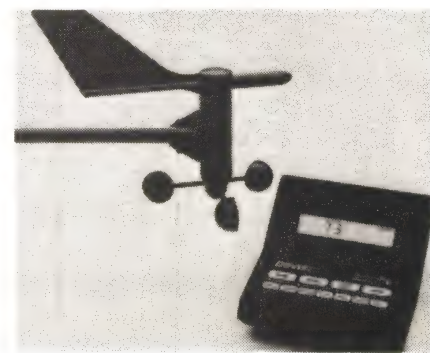
- Information Technology
- Wordprocessing
- Programming
- Business and Office Technology
- Data Processing and Information Systems.

C&G tell us that named diplomas and certificates in other subject areas will be considered in due course. Let us hope that the various electronics related subjects will be among them.

WEATHER EYE

A new range of weather monitors that enable everyone to keep an eye on prevailing conditions is now available from Davis Instruments. Shown below is the Weather Wizard II, it can measure inside and outside temperature, high and low temperature, wind direction, wind speed and wind chill and has a recording facility, alarms plus time and date. An optional extra is a rainfall monitor.

The basic unit costs £229.95 and a computer link is available plus various cables and adaptors for car/boat use etc. For further information contact ICS Electronics Ltd, Dept EE, Unit V, Rudford Industrial Estate, Ford, Arundel, West Sussex BN18 0BD. Tel 0903 731101. Fax 0903 731105.



NEW VIDEOS ON ELECTRONICS

Everyday Electronics is pleased to announce the availability of a range of videos designed to provide instruction on electronics theory. Each video gives a sound introduction and grounding in a specialised area of the subject. The tapes make learning both easier and more enjoyable than pure textbook or magazine study. They should prove particularly useful in schools, colleges, training departments and electronics clubs as well as to general hobbyists and those following distance learning courses etc.

The first three videos available are:

- ★ **1** *Electronics And You – Part 1: D.C. Series and parallel circuits and the use of a digital multimeter. Running time approx. 53 mins.*
Order code VT201 **£29.95 inc. VAT**
- ★ **2** *Part 2: A.C. Coils, capacitors, transformers and other a.c. devices. Running time approx 71 mins.*
Order code VT202 **£29.95 inc. VAT**
- ★ **3** *Part 3: Semiconductors. Basic semiconductor theory plus fifteen different semiconductor devices explained. Running time approx. 47 mins.*
Order code VT203 **£29.95 inc. VAT**

Each video uses a mixture of animated current flow in circuits plus text, plus cartoon instruction etc., and a very full commentary to get the points across. The tapes are imported by us and originate from VCR Educational Products Co, an American supplier.

To order see our Direct Book Service "Ordering Details" – the postage for tapes is the same as for our range of books and you can order tapes and books at the same time and pay only one lot of postage.

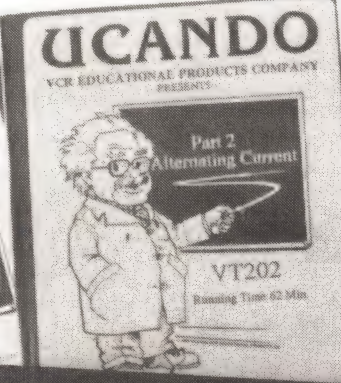
(All videos are to the UK PAL standard on VHS tapes)

£29.95

each



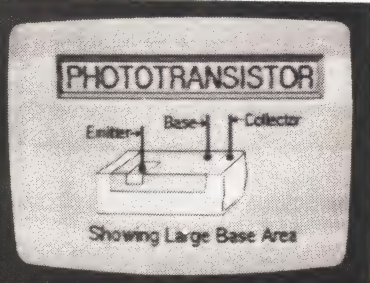
DO
VCR EDUCATIONAL PRODUCTS COMPANY
PRESENTS
Part 1
DC
VT201
Running Time 53 Min



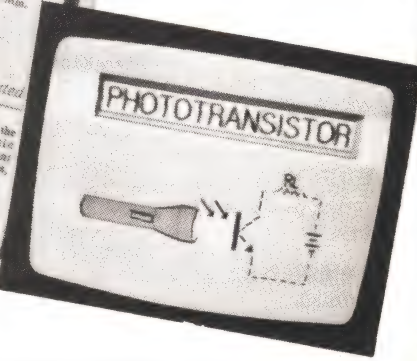
UCANDO
VCR EDUCATIONAL PRODUCTS COMPANY
PRESENTS
Part 2
Alternating Current
VT202
Running Time 71 Min



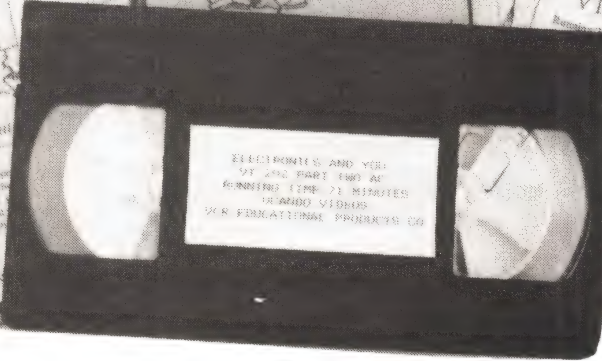
UCA
VCR EDUCATIONAL PRODUCTS COMPANY
PRESENTS
Semiconductors
VT203
Running Time 47 Min



PHOTOTRANSISTOR
Emitter Base Collector
Showing Large Base Area



PHOTOTRANSISTOR



ELECTRONIC CRICKET GAME

Steve Knight



Come rain or shine, you are sure of a perfect pitch with this enthralling game - No "Rain stopped play" signs here!

OVER the years there have been a great number of electronic games concocted for the hobbyist, including one or two cricket games. The author has felt that these latter efforts have not in some way brought out the real flavour of the game in the sense that the play does not take place on a real pitch, surrounded by players who get in the way of run-making and occasionally do their stuff by bowling the batsman out or sending him back to the pavilion by some other means.

This present offering is a portable game, suitable for two or more players, and is guaranteed to be in action whatever the

weather or the time of year. It is played on a "field" measuring 300mm by 230mm (12in. by 9in.), though this can be enlarged, or reduced, to suit your own particular liking.

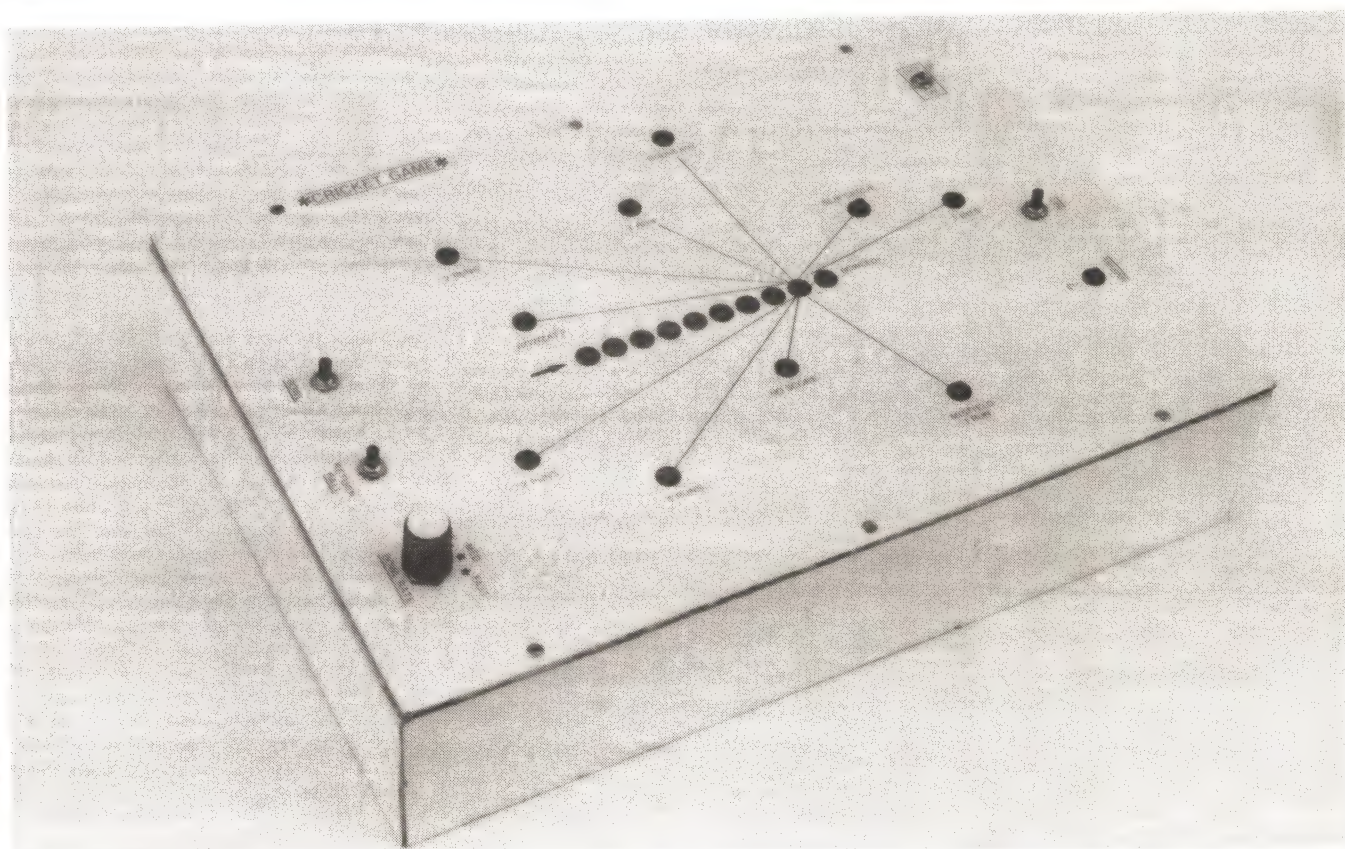
The field has a pitch which shows the path from bowler to batsman, and there are, of course, a range of bowling speeds, "slow", "medium" and "fast", to test the batsman's reaction. If he happens to take his eye off the ball, he is very likely to be bowled, and if he hits the ball it may go to any point on the ground where the possibilities of making runs, being caught or surviving an appeal to the umpire are all on

the cards. However, to the system and its construction, with more about playing the game later on.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Electronic Cricket Game is given in Fig. 1. All the components for this excepting the three control buttons S2, S3 and S4, the bowling rate switch S1 and the twenty-one l.e.d.s, are assembled on a single p.c.b. measuring 133mm by 100mm (5¼in. by 4in.). Current consumption is about 35mA using a 6V battery, though a simple power unit may be added so that the mains supply can be used.

Integrated circuit IC1 is a 7555 chip, which is a CMOS form of the familiar 555 timer (though a 555 may be used at the cost of an increased current consumption), operating as a clock generator. The pulse repetition frequency is selected by the three position switch S1 and this switch provides the three bowling rates (style).



MAKE A BIG HIT WITH YOUR FELLOW PLAYERS

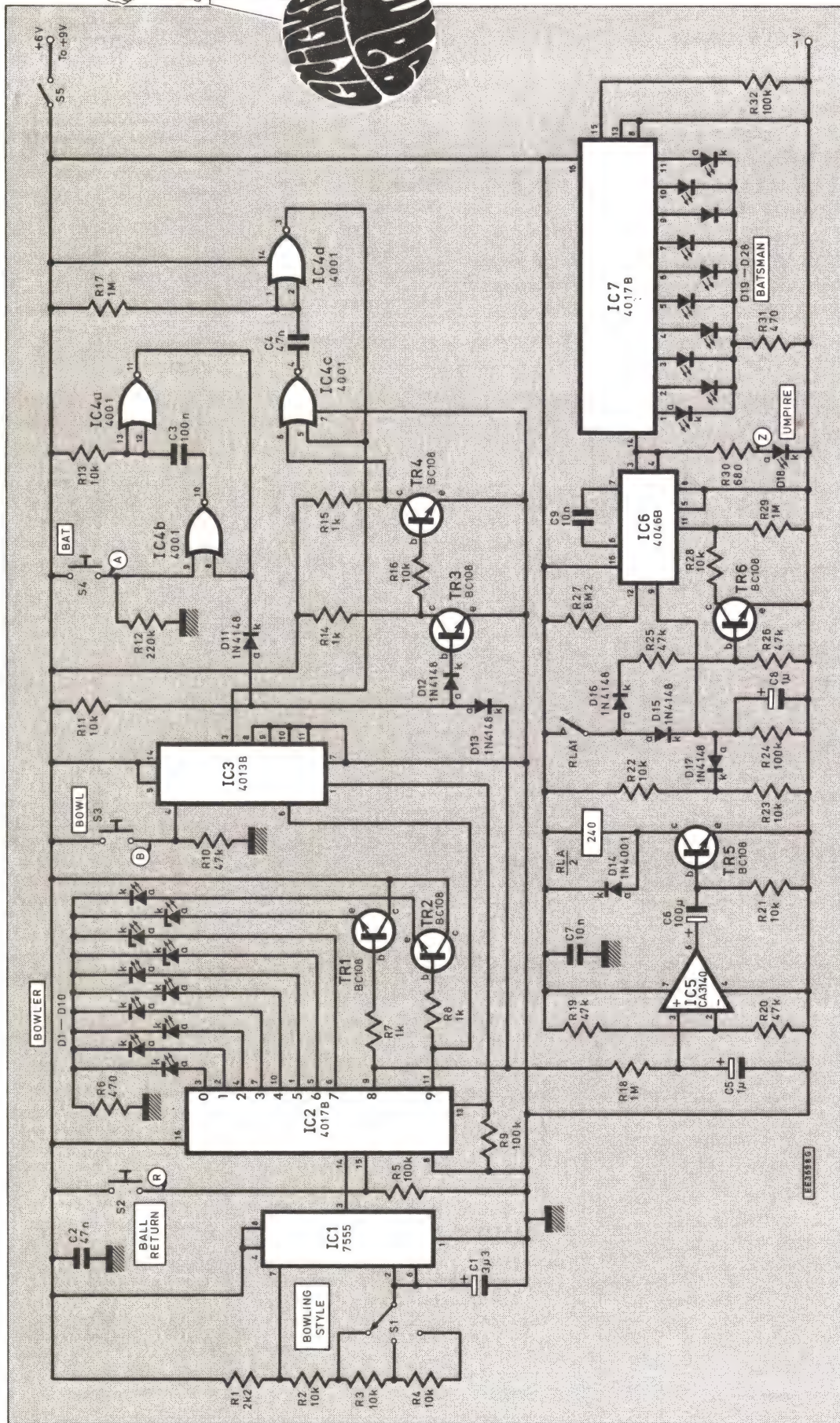


Fig. 1. Complete circuit diagram for the Electronic Cricket Game. All components except D1 to D10 and D18 to D28 inclusive, resistors R6 and R31 and switches S1 to S4 are mounted on the p.c.b. Circled letters refer to outgoing points.



BOWLING

With the component values specified, around switch S1, these rates are approximately 8, 12 and 20 pulses per second and these seem about right for the game as the author has played it. Individual constructors can easily adjust the rates to suit their own fancy.

The pulse output from the timer IC1 pin 3 is fed to pin 14 of IC2, a 4017B 5-stage decade "twisted-ring" counter, then to the output pins of IC2 which are connected to a sequence of l.e.d.s (D1 to D10 inclusive) which we might call the "Wicket Sequence". Only one of these ten l.e.d.s is on at a time, the position changing to the following l.e.d. with each successive input pulse. A running light is therefore obtained from l.e.d.s D1 to D10 at a frequency determined by the setting of switch S1.

If this running light is to emulate the movement of a ball along a pitch, from the bowler's end represented by D1 to the wicket represented by D10, the l.e.d.s must light in the correct order and necessarily stop on reaching D10, in spite of the fact that the clock pulses are continually applied. This is accomplished by allowing the run from D1 to D10 to occur while pin 13 of IC2, the clock enable pin, is held low by way of resistor R9. This pin is switched high by the Q output of a D-type flip-flop, IC3, when D10 lights and passes a high input to the reset, pin 6, of IC3.

The ball is reset to the bowler's end when necessary by the action of pushbutton switch S2; this switch is consequently labelled Ball Return. The ball then waits at the bowler's end of the pitch until the reset button switch, S3, on pin 4 of IC3 is operated; taking pin 4 high then resets the flip-flop and pin 13 of IC2 goes low, enabling the clock again to run the wicket sequence from D1 to D10. Push switch S3 is appropriately labelled Bowl.

BATTING

Now l.e.d. D10 is the "wicket" and if the "ball" reaches this, the batsman in action at the time, is deemed to have been bowled. To try to prevent this fate befalling him, "batsman" must halt the light sequence at l.e.d. D9 which is the batting position.

He can do this by pressing push switch S4 (the Batting switch) at the precise moment that the ball reaches the "bat" position (l.e.d. D9). Pressing S4 before or after this moment, or holding it down all the time, will have no effect on allowing the ball to pass the bat and scatter the stumps!

The circuit performs this function by feeding the output at the Bat position (pin 9 on IC2) to one of the inputs, via diode D13, of a discrete coincidence gate made up from transistors TR3 and TR4. The other input to this gate derives from pressing the Bat switch S4 which feeds a high signal via the anti-bounce switch comprising IC4a, IC4b and diode D11.

Only when these two inputs are *simultaneously* high does an output appear at the collector of TR4. This output is in turn fed to a monostable made up from NAND gates IC4c, IC4d which is turned on for a period of a few milliseconds determined by the values of resistor R17 and capacitor C4. The negative-going edge of this output enables IC3 by way of pin 3 and the Q output at pin 6 goes low, locking the Bat position in the wicket sequence.

Any failure to press the Bat switch while the Bat diode D9 is momentarily lit results in a low output from transistor TR4 and

the ball moves on to the wicket l.e.d. where it stays to let the batsman know he has been bowled out. This high at pin 11 of IC2 sets IC3 and changes the Q output, so locking l.e.d. D10 firmly on "out".

Reset switch S2 returns the ball to the bowler's end when required as already explained and D10 is then extinguished. The following ball can then be played by pressing the Bowl switch S3. This completes the description of the upper part of the circuit diagram.

SCORING SEQUENCE

The "scoring" or run making part of the circuit includes IC5, IC6, and IC7 and transistors TR5 and TR6. Its function is to randomly send the ball (provided it has been correctly "hit" by the resident batsman) to some part of the field where it may (or may not) score runs or, unhappily, be caught by a fielder or perhaps a loud "Howzat?" may be asked of the umpire.

When the ball has been successfully played, l.e.d. D9 is lit and this high signal remains on. Let us look first of all at that part of the circuit associated with TR6, IC6 and IC7. In the same way as the wicket sequence of l.e.d.s was operated by IC2, so the scoring sequence of ten l.e.d.s (D19 to D28) is similarly controlled by IC7, another 4017B decade counter.

The ten l.e.d.s concerned here are placed at various positions in the "field", each representing a number of runs or a no-score, plus a couple which may lead to a catch or an appeal for lbw. Our object is to illuminate one of these l.e.d.s in a random manner directly a correct hit has been made by the batsman at the crease.

What is used is a run-down clock generator of the kind often found in electronic dice games. This clock runs the sequence of l.e.d.s at a very rapid rate for a fraction of a second and then halts the process very quickly to leave just one of the indicators illuminated. This l.e.d. then tells the batsman his score – or his fate!

The control of IC7 is made by IC6, a 4046B phase locked loop i.c. which houses a voltage controlled oscillator (VCO) as part of its circuitry. The frequency at which this oscillator works is controlled by the voltage on pin 9, the resistance between pin 11 and "ground (0V)" and the value of

capacitor C9 wired between pin 6 and pin 7. A square wave output appears at pin 4. With the values used, the frequency is several kilohertz but is in no way critical for this present purpose.

When relay RLA contacts are closed (this is a relay operating as a switch – but more about this later), transistor TR6 is switched on by way of diode D16 and potential divider chain resistors R25, R26, and connects pin 11 of IC6 to ground through resistor R28. This causes the VCO to oscillate at a relatively high frequency so that an unpredictable number of pulses are fed to the input of IC7 all the time the relay contacts remain closed.

When the relay contacts open, transistor TR6 switches off and the oscillation then depends only upon the small charge remaining on capacitor C8 and the value of resistor R29. The presence of resistor R24 ensures that the oscillation falls very quickly to zero, hence the input to IC7 vanishes and only one of the scoring sequence of l.e.d.s remains on.

GOOD SHOT

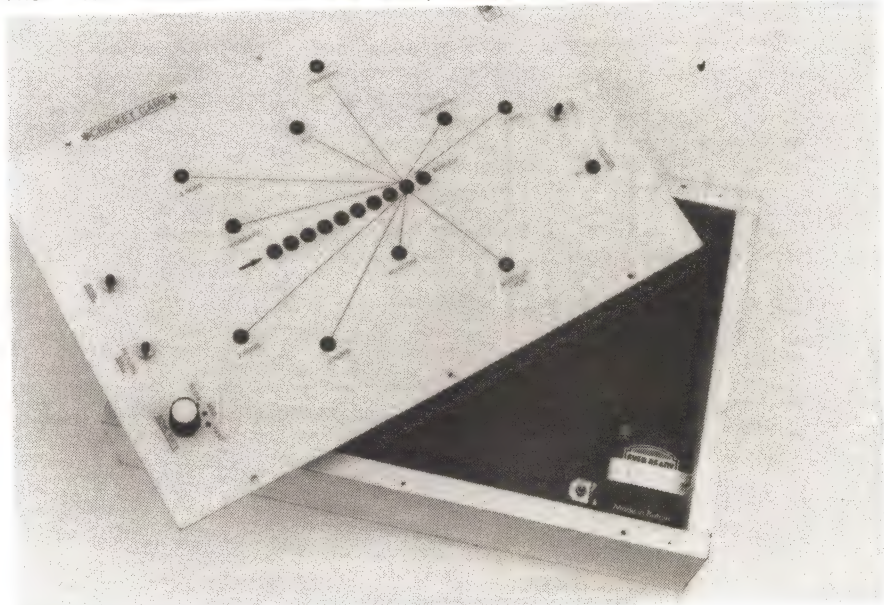
Now if the output of pin 9 of IC2 is used directly to trigger the VCO, then the scoring sequence will be set into action even if pin 9 is passed in the normal wicket sequence. This is not wanted so there has to be a circuit arrangement which does not respond to a short pulse from the batting l.e.d. but acts only if this l.e.d. remains on for a longer period, that is, when the batsman has correctly intercepted the ball.

This action takes place by way of a simple op.amp comparator, IC5, and transistor TR5. The inverting input to IC5, pin 2, is held at half the supply voltage by the divider chain resistor R19, R20. The output from pin 9 of IC2 feeds to IC5 non-inverting input (pin 3) by way of resistor R18 and capacitor C5.

This integrating combination has a long time-constant and for a momentary pulse output from IC2 does not allow the voltage across capacitor C5 to rise much above ground. The voltage on pin 3 of IC5 stays, therefore, below that on pin 2 and the output at pin 6 remains low.

For a sustained output from IC2 however, capacitor C5 is enabled to charge up to a level exceeding that on pin 2 of the op.amp and the output switches high, so

The "Pitch" slid back to reveal the battery clamped in one corner of the case



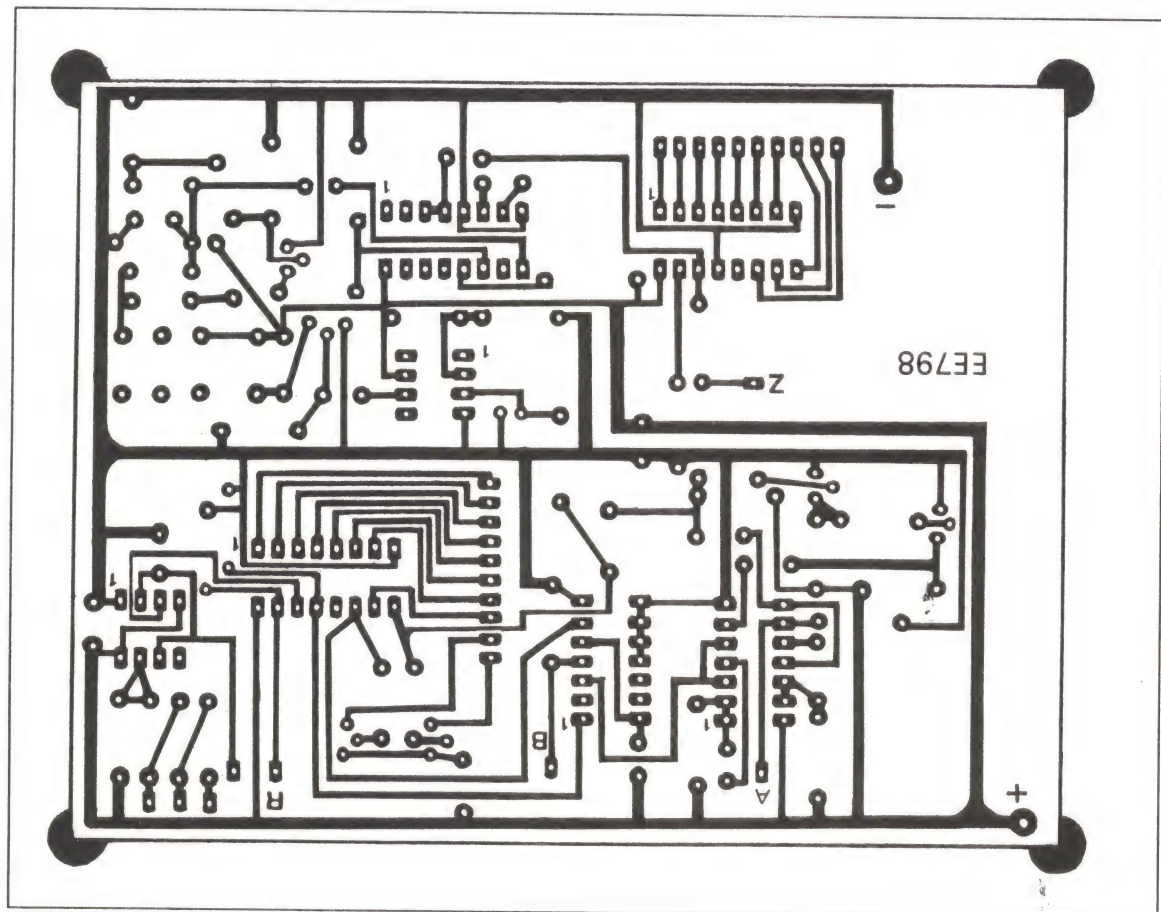
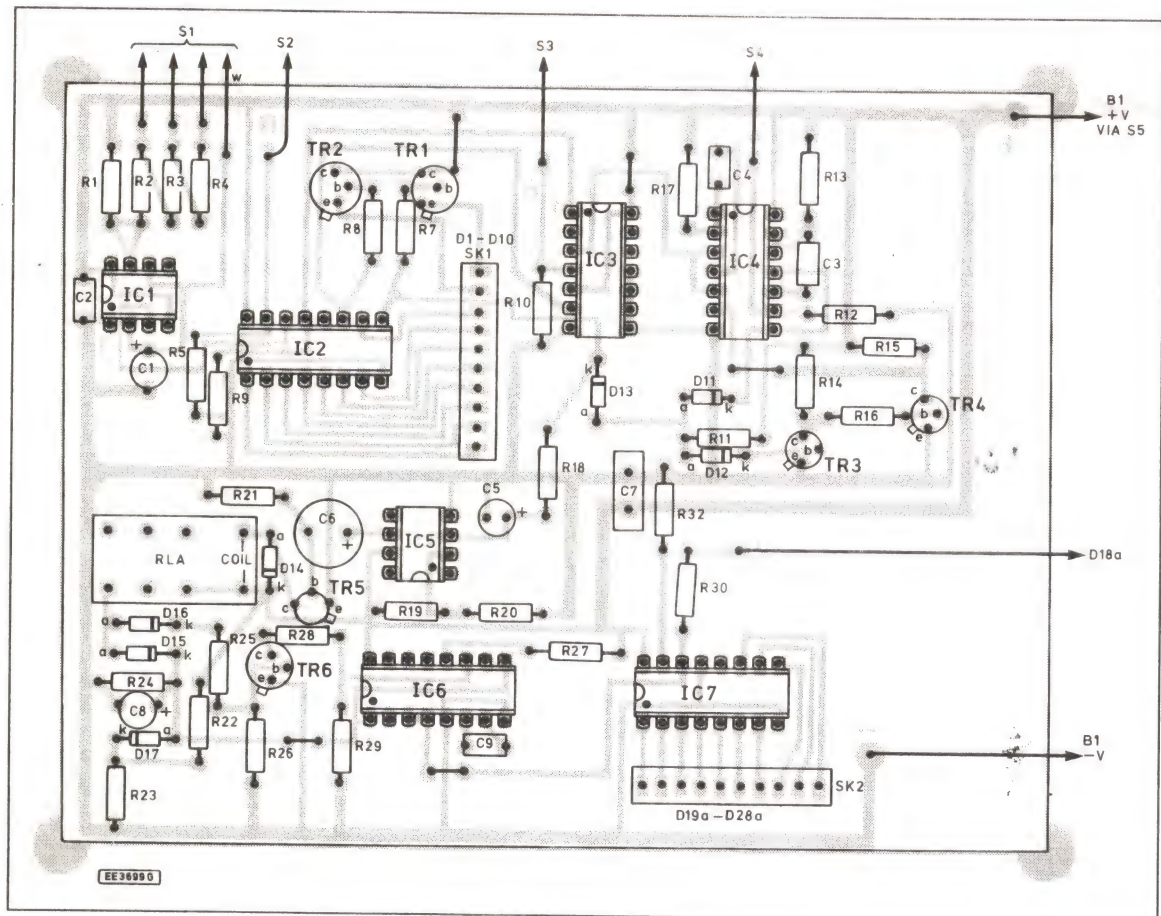


Fig. 2. Printed circuit board component layout and full size copper foil master pattern for the Cricket Game.

(Right) Completed prototype printed circuit board. The transistors here have been replaced with BC108 types.

(Bottom right) Pitch layout on the completed board.

COMPONENTS

Resistors

R1	2k2
R2, R3, R4,	
R11, R13,	
R16, R21,	
R22, R23, R28	10k (10 off)
R5, R9, R24, R32	100k (4 off)
R6, R31	470 (2 off)
R10, R19, R20,	
R25, R26	47k (5 off)
R12	220k
R7, R8, R14,	
R15	1k (4 off)
R17, R18, R29	1M (3 off)
R27	8M2
R30	680

Capacitors

C1	3 μ 3 tantalum bead, 35V
C2, C4	47n min. polycarbonate or poly layer (2 off)
C3	100n min. polycarbonate or poly layer
C5, C8	1 μ min. radial elect. (2 off)
C6	100 μ radial elect., 35V
C7, C9	10n min. polycarbonate (2 off)

Semiconductors

D1-D10,	
D18-D28	5mm high efficiency l.e.d.s (8 yellow, 5 red, 8 green)
D11, D12,	
D13, D15,	
D16, D17	1N4148 signal diode (6 off)
D14	1N4001 1A 50V rect. diode
TR1-TR4,	BC108 npn transistor
TR5, TR6	(6 off)
IC1	ICM7555 CMOS timer or NE555 timer
IC2, IC7	4017B decade timer (2 off)
IC3	4013B dual D-type flip-flop
IC4	4001 quad 2-input NOR gate
IC5	CA3140 MOSFET op.amp
IC6	4046B phased locked loop

Switches

S1	4-pole 3-way min. rotary, Lorlin
S2, S3,	
S4	Miniature pushbutton, normally open
S5	Miniature s.p. on-off

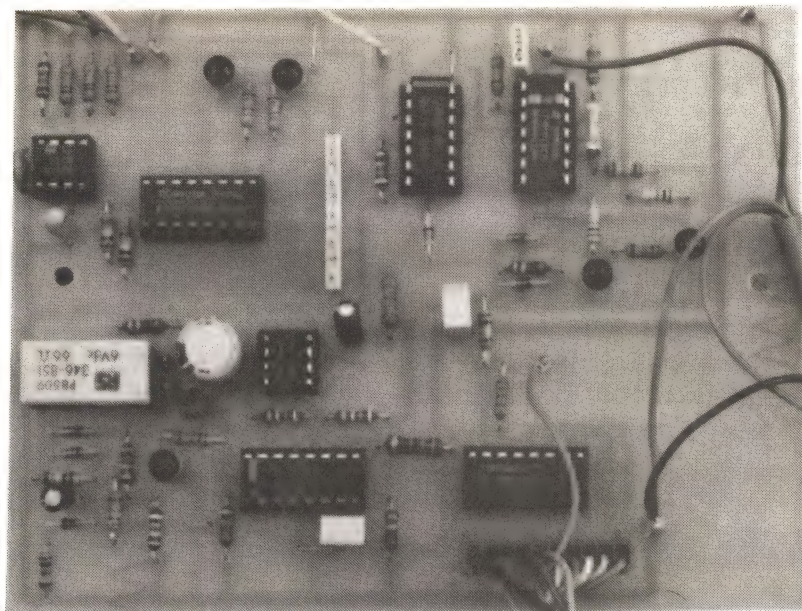
Miscellaneous

RLA	6V 240 ohm coil d.i.l. relay, with d.p.c.o. contacts (only one set used).
-----	---

Printed circuit board available from *EE PCB Service*, code EE798; 8-pin d.i.l. socket (2 off); 14-pin d.i.l. socket (2 off); 16-pin d.i.l. socket (3 off); 5mm l.e.d. mounting clips (21 off); 14-way tag strip; two pieces of hardboard or plywood (3mm) to required size; two 10-way header pin strips and connectors (if used - see text); 13mm ($\frac{1}{2}$ in.) brass gimp pins (24 off - see text); connecting wire; solder etc.

Approx cost
guidance only

£25



turning transistor TR5 on and operating the relay which closes RLA1 contacts. This closure is only momentary because of the differentiating action of the coupling components capacitor C6 and resistor R21, and the rest of the circuit is then activated in the way already explained.

The use of relay at this point may seem a bit odd as the switching could be electronically activated, but the use of a mechanical relay introduces a small but desirable time variation (as well as possible bounce!) in the duration of the relays closure and so helps in enhancing the random operation of IC6 during the short time that the VCO is producing its high frequency output.

Only the function of diode D18 remains to be mentioned. This l.e.d. is the game's "Umpire" and gives a verdict for or against the batsman.

The output of IC6 may, when the VCO oscillations cease, settle randomly in either the "high" or "low" state. In the former case D18 will be lit and in the latter case it will be extinguished. If the D18 l.e.d. is lit, the appeal is allowed. We will return to this point when the actual method of play is discussed.

CONSTRUCTION

There are essentially three parts in the construction of the game: first, the assembly of the printed circuit board (p.c.b.) which is quite straightforward; secondly, the assembly of the wicket and fielding l.e.d.s on to the board which can be a piece

of thin plywood or hardboard sheet, an assembly which is a bit fiddly but not insurmountable; thirdly, the fabrication of a very simple box which holds the finished job in a nice compact manner.

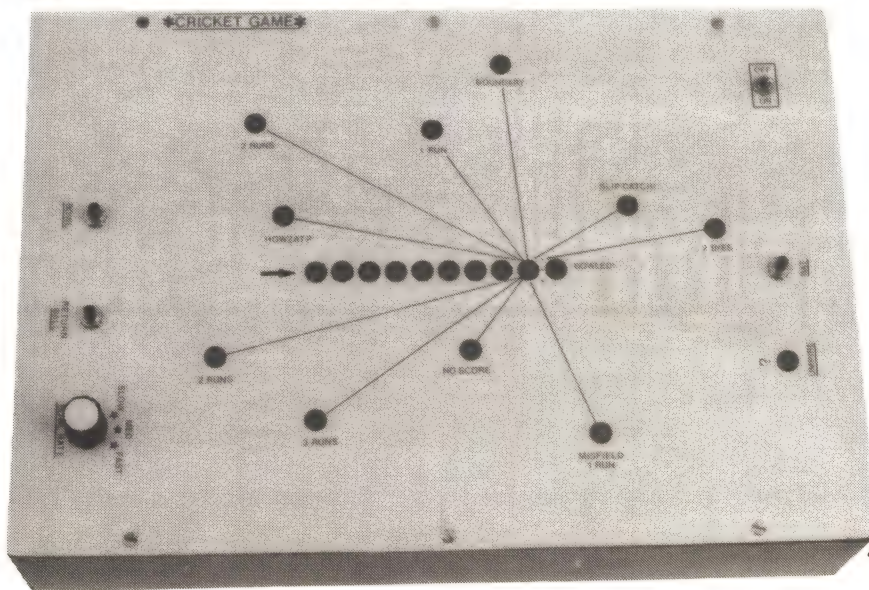
The component layout and full size copper foil pattern of the printed circuit board is shown in Fig. 2. This board is available from the *EE PCB Service*, code EE798.

There should be no problems in assembling this board provided all the usual precautions about soldering and the orientation of polarized components are observed. The integrated circuits are best mounted in low-profile holders, otherwise there is little to comment on.

On the prototype the l.e.d. outputs from IC2 and IC7 terminate on 10-way header strips; this is done purely for convenience in the later interconnections stage and you can, if you wish, simply connect ordinary outgoing wires or ribbon cable at these points for later connection to the various l.e.d.s. Different coloured wires are essential to avoid confusion. Solder pins are fitted to the other output points, that is, the various switch connections and the output to the "Umpire" l.e.d. D18.

PITCH

Turning now to the actual pitch, the layout of the prototype is shown in Fig. 3. This was made on a piece of 3mm hardboard measuring 300mm by 230mm (12in. by 9in.) although you can adjust these measurements to suit yourself; nothing else is affected by this.



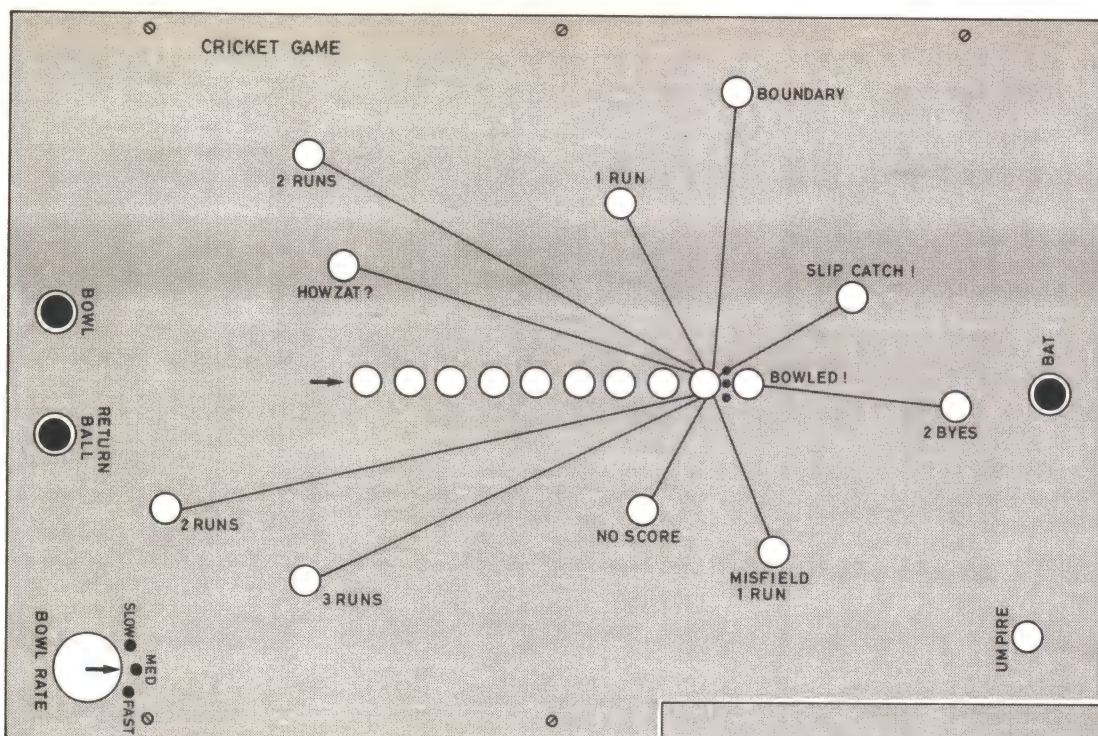


Fig. 3. Suggested field layout. The "wicket" l.e.d.s are spaced 10mm apart.

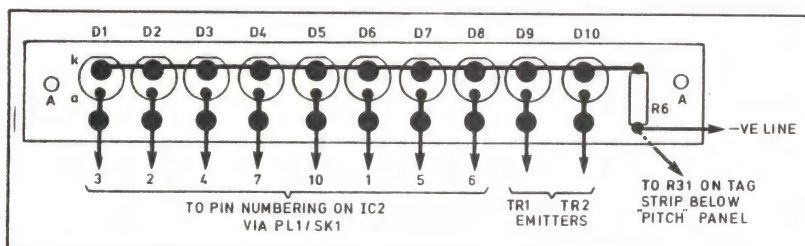


Fig. 4. Using a small board to wire the wicket l.e.d.s. This board could be made from stripboard.

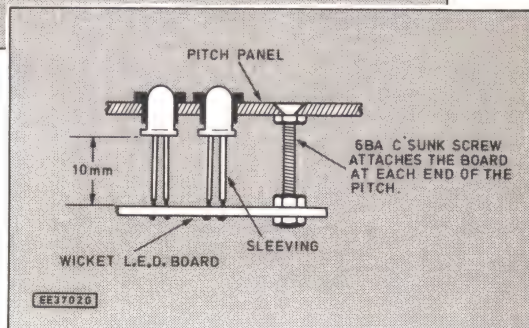


Fig. 5. How the l.e.d.s are mounted on the subsidiary "wicket" board and fixed to the pitch panel.

The l.e.d. holes are all drilled 6mm ($\frac{1}{4}$ in.) diameter as are the specified pushbutton switch holes. The bowling rate switch S1 needs a 9mm ($\frac{3}{8}$ in.) hole and there are six fixing holes along the longer edges to take ordinary wood screws when the "ground" is later attached to a simple case. Two 6BA countersunk clearance holes are also required at each end of the wicket to support a small auxiliary p.c.b. which carries the ten l.e.d.s associated with the wicket sequence.

Additionally, two pins are driven into the hardboard on each side of the "fielders" l.e.d.s, but we return to these points in a short while. In the layout of the fielding positions you can, of course, do your own thing; a piece of 3mm ply, may be substituted for the hardboard and the various fielding points (and the scores or penalties associated with them) can be moved around to please yourself. The central "pitch" should not, however, be altered in any way.

WICKET SEQUENCE

The board which holds the wicket sequence l.e.d.s is shown in Fig. 4. The l.e.d. spacing is 10mm and the panel drilling must, of course, be identical with this.

The ten l.e.d.s are fitted to the board as Fig. 5 illustrates, making sure that the cathodes (k), usually indicated by a flat on the l.e.d. casing, go to the common wire which connects to one side of resistor R6. The other side of R6 has a wire attached

which should be taken to the common (-V) foil track on the main board.

The use of sleeving on the l.e.d. wires ensures that they are all at the same height above the board. Also make sure that they are in line when viewed along the length of the sequence.

Preferably use yellow l.e.d.s for pitch positions D1 to D8, with a green for the batsman's position (D9) and red for the wicket (D10). Fig. 5 also shows how the board is fitted to the panel - but don't do this just yet.

FIELDER'S SEQUENCE

Wiring up the fielder's l.e.d.s is a bit fiddly because these have to be hard wired and it is necessary to provide some sort of anchorage at each of the indicator positions. The method used (and you may well think of a better one!) is to drive two brass gimp or panel pins into the panel on each side of each of the l.e.d.s such that the l.e.d. wires can be looped around (no tightness here) and be soldered to the pins rather as Fig. 6 shows. Don't use steel pins as there is then a possible soldering problem without acid fluxes, though brass or coppered style pins can be employed.

A simple wiring harness can then be made up to bring the eleven anode (a) points (including D18 here) and the common cathode (k) wire to a tag strip, twelve connections in all. Wires from this tag strip then go down to the main p.c.b. The

photograph shows the completed underside of the pitch panel.

COMPLETING THE ASSEMBLY

Before mounting and wiring up the panel l.e.d.s, a bit of preparation is needed if the finished job is going to look neat and presentable. The two 6BA screws for the "wicket" l.e.d.s and the gimp pins for the anchorage of the others must be fitted and the surface blemishes left by these levelled off with a filler and smoothed with fine sandpaper, before anything else is done.

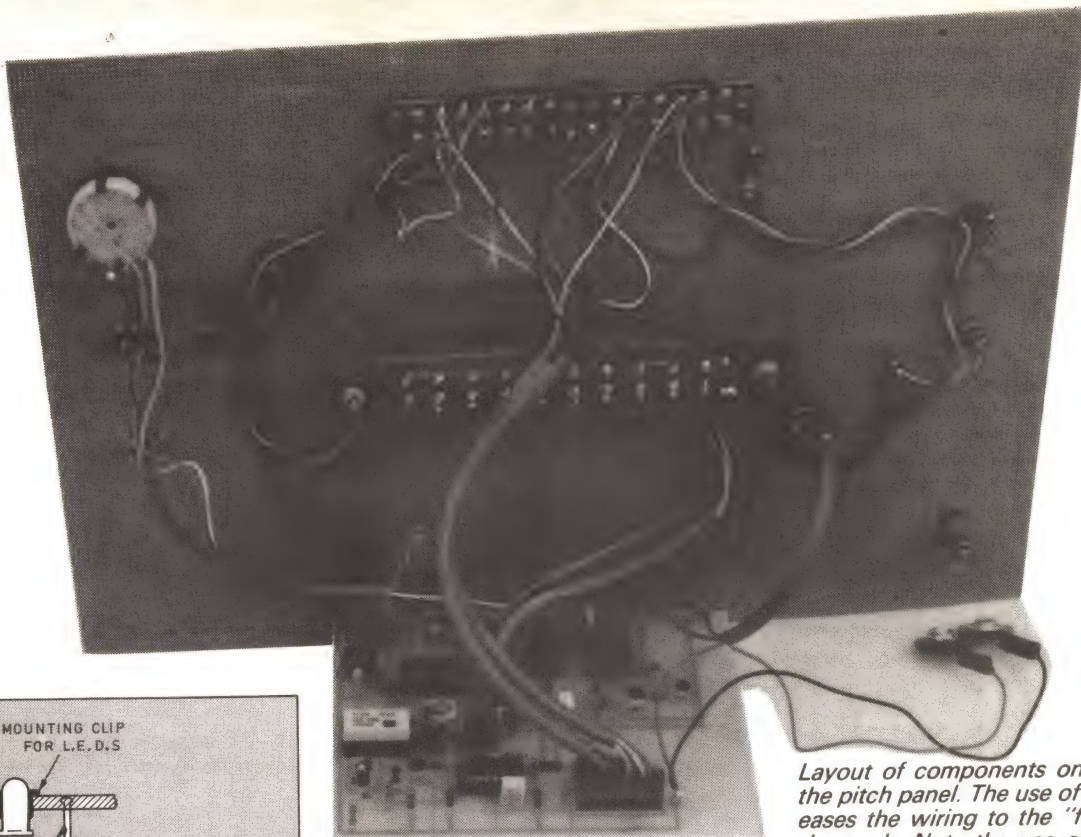
A coat of paint is now required to simulate the field. A light green is best and matt emulsion or undercoat, preferably rolled on, is ideal. Alternately, a piece of light green paper might be glued over the hardboard.

Whatever you use, all the legends should next be added using rub-down lettering, after which the l.e.d.s and the switches can be mounted. Use green l.e.d.s for the scoring positions and red for the "out" positions and Howzat?

To tidy up the l.e.d. holes, use panel bushes which fit into the 6mm ($\frac{1}{4}$ in.) holes already drilled and the l.e.d.s themselves then snap into these.

To make up a box, get a piece of hardboard the same size as the panel for the box bottom. Screw to this as the sides of the box four pieces of wood of thickness about 9mm ($\frac{3}{8}$ in.) to give a depth of about 51mm (2in.).

The main p.c.b. along with a suitable



Layout of components on the rear of the pitch panel. The use of the tag strip eases the wiring to the "fielders" and the p.c.b. Note the use of the header connections on the p.c.b.

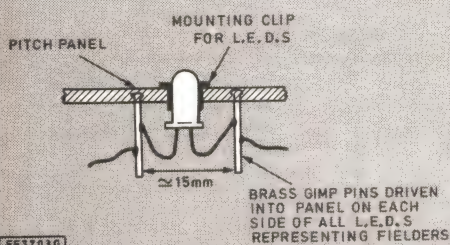


Fig. 6. How the "fielders" are mounted and wired on the pitch panel.

battery (or a simple mains unit if you wish) are fixed to the base, and the interconnections between the field panel and the p.c.b. can then be made. Prop the panel against one side of the box to do this; don't make the leads so short that there is a strain on any connection. You want to be able at any time to get into the box, perhaps to change the battery, and you want to be able to flip the lid (the field) back as though it was on a hinge in order to do this.

Apart from the "Howzat/Umpire" l.e.d. (D18) which connects to resistor R30 on the board, the other fielding l.e.d. anodes can go to any of the output pins of IC7, the whole sequence being random anyway, unlike the wicket sequence which must be wired to the outputs of IC2 in the correct order. In this it is essential to note that the diode numbers (apart from D2 and pin 2) do NOT coincide with the pin numbers on IC2.

The correct sequence is shown in Fig. 1 and must be followed, i.e. D1 to pin 3; D2 to pin 2; D3 to pin 4, and so on to D9 to

emitter (e) of TR1; D10 to emitter of TR2. The common lead returns through resistor R6 to the negative line. Unless you get this order right, you are going to bowl some amazing googlies!

PLAYING THE GAME

The bowler's end of the field has three control points: two pushbutton switches marked Bowl and Return Ball respectively, and the Bowling Rate selector switch. At the batsman's end there is one pushbutton switch marked Bat and the Umpire l.e.d.

When the game is initially switched on a number of the field l.e.d.s may light up, but by pressing the Return Ball button the bowler positions the ball at his own end of the pitch. At this point one of the field l.e.d.s will be lit but this is ignored. The game is now ready to play.

The bowler starts things off by pressing the Bowl button; the "ball" will then move down the pitch at a rate selected by the Bowling rate switch. When the ball reaches the batsman's position (l.e.d. D9) the batsman must simultaneously press the Bat button to halt the ball on this l.e.d.; this constitutes a hit and the field display will then indicate his score or his penalty.

If the ball is missed by the batsman, the

wicket will be hit and the tenth l.e.d. will light. The batsman is then dismissed. The bowler returns the ball to his own end and prepares for the next delivery.

The fielding scores are self explanatory but if the Howzat l.e.d. lights, reference must be made to the "Umpire" which is the l.e.d. next to the batsman's button. If this l.e.d. is lit, the batsman is adjudged out lbw; if the l.e.d. is not lit, the verdict is not out.

It is suggested (though you can make your own rules) that each "side" (even if there are only two players) play through ten wickets each (or to an agreed score), recording each score along with any extras and how out. The bowling rate for each batsman should start off at Slow for the first "over" of six balls, then go to Medium for the next over, and Fast for the third over; this sequence then repeating if the same batsman is still at the crease. For the enthusiast, a second innings might be played to determine the outcome, with a side following on if it fails to come within an agreed number of runs of its opponents score.

Clearly, any reasonable number of players can have a go at this game, taking it in turns to bat and bowl. An individual scorer might be useful where an odd number of people are concerned.

SUPPLIES

A brief note about power supplies might not be out of place here. The unit will run quite satisfactorily on a 6V battery supply, though this should be made up of four U2 size cells, in preference to the small single 6V batteries. You may, if you wish, use a 9V supply, but this does increase the current consumption and is not so economic.

A simple mains unit is the best bet if you are going to play the game a lot, or indoors, and a suitable circuit is shown in Fig. 7. This can be easily assembled on a suitable board or piece of stripboard and will provide an output of about 8V.

Good batting!

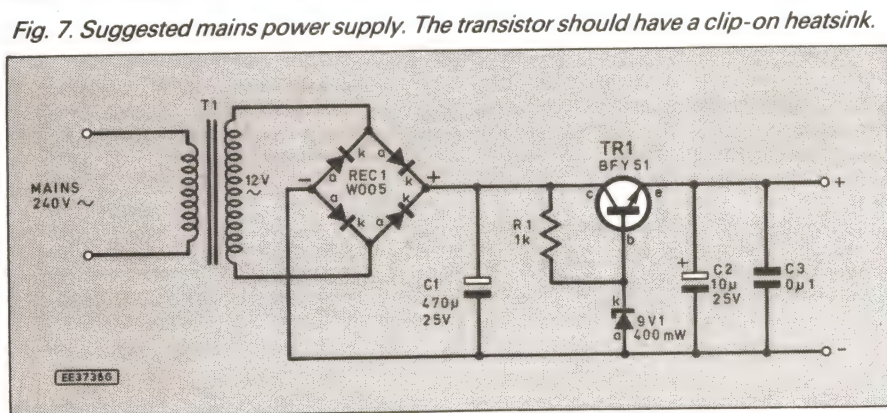


Fig. 7. Suggested mains power supply. The transistor should have a clip-on heatsink.

ACTUALLY DOING IT!

by Robert Penfold

SOME time ago the topic of mains power supplies was covered in an *Actually Doing It* article, but it is worthwhile covering broadly the same ground again here. It is a subject which seems to provide a small but steady flow of readers' letters.

Mains transformers seem to be the main cause of problems, and I suppose that when building power supplies you do sometimes have to connect the transformer in an apparently illogical manner. However, if you look at things in the right way it is all quite logical and straightforward.

DANGERS

Before proceeding further the usual warnings about working with the mains supply have to be given. For anyone building their first few projects the best advice is to avoid any mains powered project. Choose battery powered projects as these enable you to make mistakes without any drastic consequences. If you make an error in a project powered from a PP3 size 9 volt battery, about the worst that will happen is that one or two semiconductors will be destroyed. It is quite possible that no damage at all will result, and there is probably no risk at all of any personal injury.

If you make a mistake when building a mains powered project there is almost certain to be some damage, even if it is only something minor such as a blown fuse and a damaged switch. A serious error could easily result in every semiconductor in the project being destroyed, possibly in spectacular fashion. At worst you would get a severe electric shock, which could prove fatal.

When dealing with the mains supply you should proceed with the same care you would exercise if your life depended on it, because it does!

Here are some do's and don'ts:

Never work on any project that is connected to the mains supply. It is not enough to switch off at the mains supply or at the project's on/off switch. The device *must be unplugged* from the mains socket.

If you are not sure about the right way to connect something in a mains power supply circuit, do not resort to trial and error. This could cause expensive damage and could be extremely dangerous.

Youngsters should not construct mains powered projects unless they are supervised at all times by a suitably experienced adult.

Mains powered projects should always

be housed in cases that have a screw fitting lid. Do not use types having clip-on lids, slide-in panels, etc. It should not be possible to get at the dangerous mains wiring without using a screwdriver or other tool.

Any exposed metal must be reliably earthed to the mains Earth lead. The normal way of ensuring this is to use a case of all-metal construction which is connected to the mains earth lead. Any screws etc. fitted on the case will then be earthed via the case.

Even if you normally do not bother too much about checking the wiring before trying out a new project, always at least *double-check the mains wiring on any mains powered projects.*

TRANSFORMATIONS

A mains power supply should always include a mains transformer. With modern circuits that run on low voltages the mains transformer provides two functions. One of these is simply to reduce the 240 volt mains supply down to the much lower voltage required by the circuit.

The second, and no less important function, is to provide safety isolation. There is no direct connection between the mains input to the primary winding and the low voltage output from the secondary winding of a mains transformer. This ensures that anyone touching any wiring on the output side of the mains transformer will not be in contact with the mains wiring, and that (providing the secondary is a low voltage winding) they cannot receive a severe electric shock. In fact, provided the secondary potential is only around 30 volts or less, you cannot get a noticeable shock from the secondary circuitry.

Of course, the wiring on the primary side of the transformer connects to the

mains supply, and is potentially lethal. Also any transformer with a high voltage secondary winding (of the type used to power most valve circuits) is potentially lethal. Due care must be taken to ensure that none of the primary wiring comes into electrical contact with the wiring on the secondary side of the transformer.

SECONDARY EDUCATION

Many modern mains transformers are designed to be versatile, but this versatility can (and does) cause a certain amount of confusion. It is now quite common for mains transformers to have two secondary windings that are identical. These can be connected in three basic ways.

Suppose that a transformer has two 6 volt 250 milliamp secondary windings. These could actually be used as two separate windings driving separate supply circuits, but it would be very unusual for a transformer to be used in this way.

SERIES

A more likely method of connection is with the two secondary windings connected in series, as shown in Fig.1(a). This effectively adds the two 6 volt windings to give a combined output potential of 12 volts. The current rating of the combined secondaries is the same as when they are used separately, 250 milliamps in this example.

Note that this method of series connection will not work properly if you link two 0 volt or two 6 volt terminals. This will wire the windings in series, but their phasing will be such that the output of one winding will cancel out the output from the other. The result is no output whatever.

The second method of connection is much the same as the series one just described, but the interconnection between the two secondaries is utilized, as shown in Fig.1(b). This effectively gives a 6-0-6 volt transformer having a current rating of 250 milliamps. A transformer of this type is needed with a power supply that has push-pull full-wave rectification (the type that uses only two rectifiers).

It seems that this is the method of connection that causes the most confusion, and the correct way of connecting the secondary windings is not really the obvious one. The obvious way of handling things is to connect together the two 0 volt terminals in order to give the central 0 volt output. The two 6 volt terminals would then provide the two 6 volt outputs.

Although this may seem to be the

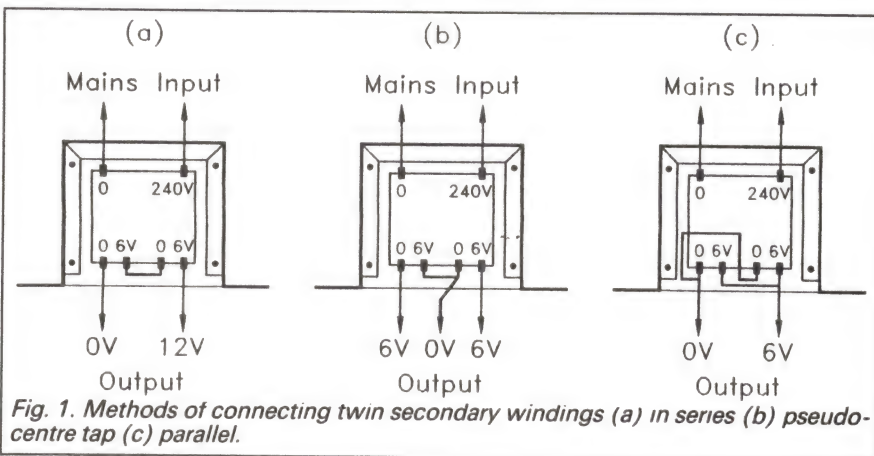


Fig. 1. Methods of connecting twin secondary windings (a) in series (b) pseudo-centre tap (c) parallel.

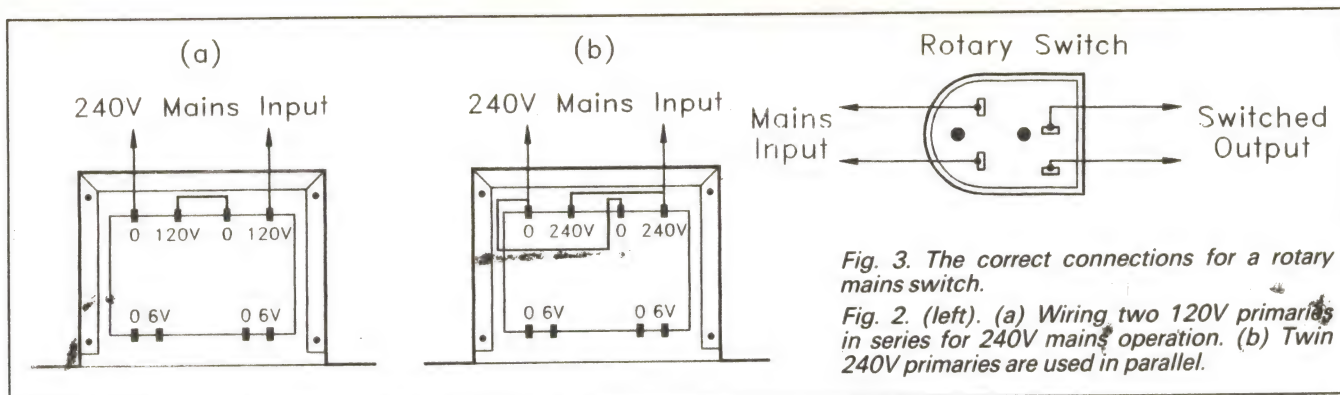


Fig. 3. The correct connections for a rotary mains switch.

Fig. 2. (left). (a) Wiring two 120V primaries in series for 240V mains operation. (b) Twin 240V primaries are used in parallel.

logical method of connection, it will definitely not provide the desired result. The two 6 volt outputs will be in-phase, whereas it is out-of-phase signals that are required.

This would effectively reduce the power supply to a simple half wave rectified type. The practical result would be substantially reduced maximum output current, and a lot of ripple on the d.c. output. This would almost certainly prevent the main circuit from working properly. The connection method shown here gives the correct anti-phase outputs, and a suitable alternative to a true centre tapped secondary winding.

PARALLEL

The third method is to connect the two windings in parallel, as shown in Fig.1(c). It has to be stressed that this method of connection is only acceptable if the mains transformer is a type which has accurately matched secondary windings which are intended for use in this way. If the retailers catalogue or other literature does not specifically state that a mains transformer is suitable for this parallel operation, it should be assumed that it is unsuitable for use in this manner.

With parallel operation the output voltage is equal to the voltage rating of one winding, or 6 volts in this case. However, the current rating is the sum of the individual current ratings, or 500 milliamps in this case.

Having twin and matched secondary windings clearly makes a mains transformer very versatile, but it also means that you have to be rather more careful when wiring it up. Make sure that you do not get a link-wire in the wrong place so that it short circuits a secondary winding.

This could easily result in the transformer being ruined. Also be careful not to use series connection where parallel connection is required. This would give double the required output voltage which could easily cause damage to the power supply components and beyond. Other errors are unlikely to cause any damage – the supply will simply not function correctly.

PRIMARY EDUCATION

Provided a mains transformer has a single primary winding there should be no difficulty in wiring up this section of the supply. Unfortunately, a substantial proportion of modern mains transformers have either twin primary windings, or a tapped winding. The latter is the easier to deal with. If the transformer is suitable for operation on the 240 volt UK mains supply it should have terminals marked "0V" and "240V", and these are the two terminals to which the mains input should be connected. The other tags are left unconnected.

Some mains transformers seem to have twin 120 volt windings, and this is presumably to permit them to operate on continental 120 volt supplies or the 240 volt UK supply. For operation with the latter the two windings *must* be wired in series (Fig.2(a)).

From time to time I have encountered mains transformers which have twin 240 volt primary windings. I have never been able to ascertain just why such an arrangement should exist, since there would seem to be no 480 volt mains supplies. Series connection of the windings would therefore seem to be something that would never be used in practice. The only suggestion that I can offer is that this system enables mains

transformers of various ratings to be put together from a limited number of standard sub-assemblies. This would presumably help to keep down production costs.

Anyway, if you should encounter one of these transformers, the primary windings are connected in parallel, as shown in Fig.2(b). Note that the same basic method of connection is used for transformers which have twin 120 volt primary windings when they are used with continental 120 volt mains supplies.

ROTARY SWITCH

It is essential to get the on/off switch of a mains power supply connected correctly. If you should get it wrong, you will probably find that switching on has the effect of short circuiting the mains supply through the on/off switch! The fuse in the mains plug (which should be a 2 or 3 amp type for most projects) should "blow" and prevent any serious problems. The on/off switch might not survive the experience though.

With most switches the correct method of connection is fairly obvious, but if in doubt it is always a good idea to check any switch with a continuity tester before making any connections to it. A few checks will soon show which tags (if any) connect together at each position of the switch.

The switches I find the most awkward to deal with are the mains rotary on/off switches that are supplied by several of the main electronic component retailers. Checks with a continuity tester have invariably revealed that I was about to connect the switch incorrectly. Fig.3 shows the correct method of connection for this type of switch.

**1992
CATALOGUE
NOW FREE**

CRICKLEWOOD

ELECTRONICS

CRICKLEWOOD ELECTRONICS LTD, 40 CRICKLEWOOD BROADWAY, LONDON NW2 3ET
Tel: 081 452 0161 Fax: 081 208 1441

BOOKS 	BOXES & CASES 	CABLE & WIRE 	CAPACITORS 	CONNECTORS 	KITS
RESISTORS 	SEMI-CONDUCTORS 	SPEAKERS 	VIDEO HEADS 	SWITCHES 	TOOLS & BENCHWARE

SEND NOW FOR THE **CRICKLEWOOD ELECTRONICS** COMPONENT CATALOGUE
 ONE OF THE BEST RANGES AVAILABLE

Name.....

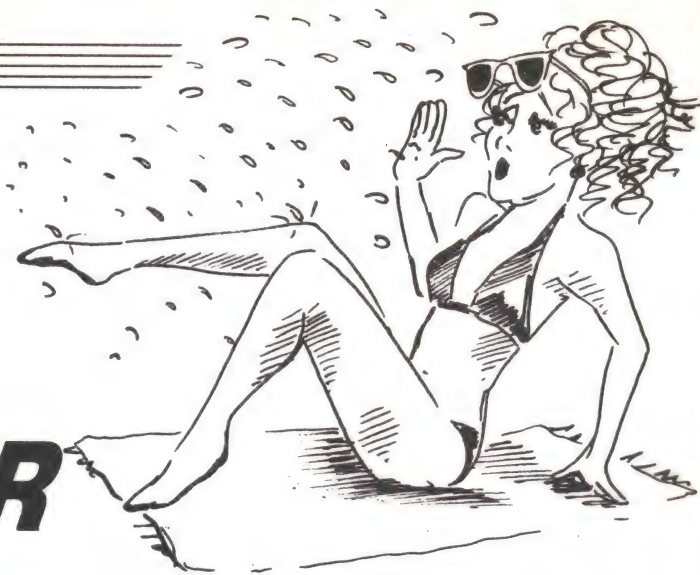
Address.....

.....

.....

.....

GARDEN HOSEPIPE CONTROLLER



T. R. de VAUX-BALBIRNIE

No need for your prize plants or garden produce to feel neglected while you take your annual holiday.

THIS mains-pressure hosepipe controller is designed to keep your garden watered while you are away from home. This does it by operating a sprinkler for a preset time each day. A control on the front panel adjusts the operating time between limits of less than one second and four minutes approximately.

However, these timings could be easily altered if required. It would also be a simple matter to alter the "daily" timing to a period of more or less than one day. A reset button may be used to cancel operation and a further pushbutton switch used to trigger the unit at any time.

Readers should realize that this device does not provide precise "daily" timings and that these will drift with ambient temperature. Under reasonably constant temperature conditions, the prototype unit provided a time period of 24 hours within two to three minutes.

When the temperature changes, the timing period will vary by up to two minutes

per degree approximately. Readers requiring precision timings, perhaps for other purposes, should use an alternative circuit. Further details about the effect of temperature on time periods are given towards the end of the article.

WATER SUPPLY

The device which controls the supply of water to the sprinkler is a 12V d.c. solenoid valve. The specified valve will operate at mains water pressure and has standard $\frac{1}{2}$ in. b.s.p. threaded male ends.

Connectors may be obtained from a local plumber's merchant or DIY store to enable it to be fitted to a standard threaded water tap at one end and the hosepipe itself on the other. It is essential to use proper secure fittings especially if the unit is to be left unattended.

Although for safety the main unit must be situated indoors, the hosepipe and solenoid valve will probably be outside but so sited that catastrophic failure of the circuit or

a sticking solenoid valve would not cause problems with flooding. The wire connecting the main unit to the solenoid valve may be of a light-duty twin type of any reasonable length.

The Garden Hosepipe Controller is mains-powered so needs a supply socket available nearby. It must **NOT** be connected **permanently** to the mains. Under standby conditions, the circuit requires 20mA approximately and while operating the solenoid valve, 200mA. Thus, the cost of powering the circuit is negligible.

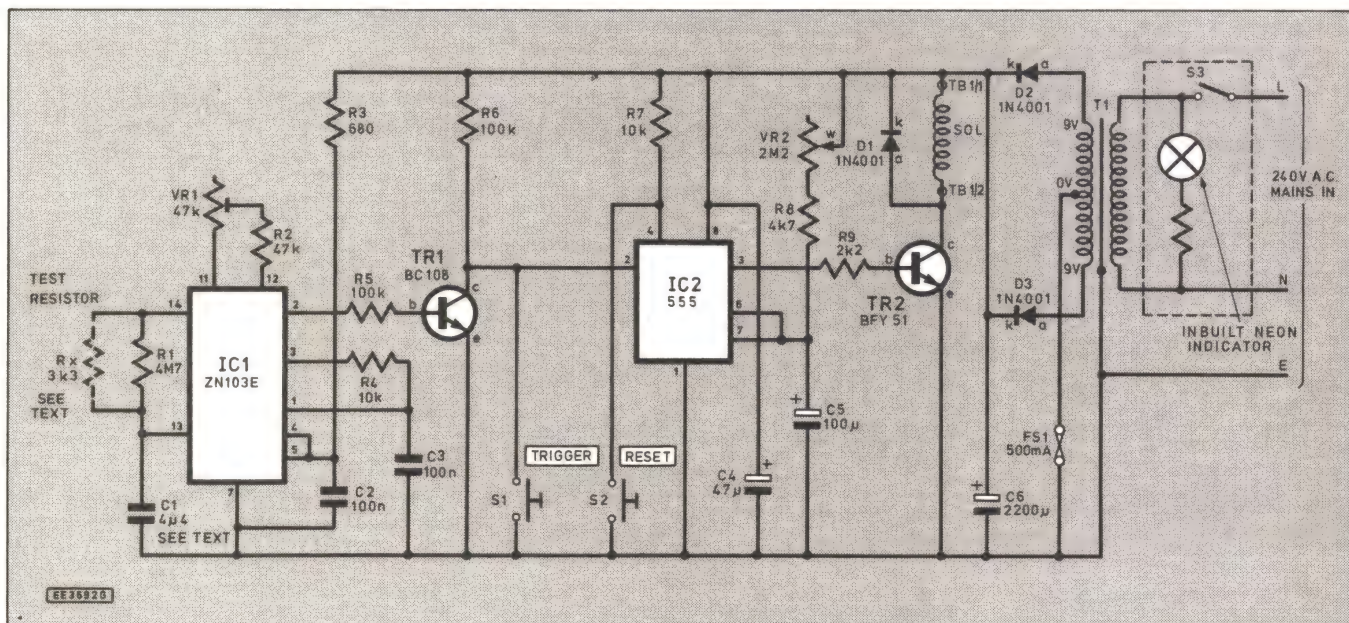
CIRCUIT DESCRIPTION

The full circuit diagram for the Garden Hosepipe Controller is shown in Fig. 1. IC1 is a precision timer integrated circuit. This is a sophisticated device which operates in the following way.

With a power supply established, timing capacitor C1 charges through fixed resistor R1. The time (nominally 21 seconds) taken for the voltage to reach a predetermined level is recorded by an on-chip 12-stage binary counter. C1 now discharges and repeats the cycle.

When 4095 such charge/discharge cycles have been counted the two outputs, pin 2

Fig. 1. Complete circuit diagram for the Garden Hosepipe Controller.



and pin 3, change state – pin 2 going from low to high and pin 3 from high to low. With the values of C1 and R1 specified, the time taken to do this is nominally 24 hours. Preset potentiometer VR1, in conjunction with fixed resistor R2 connected between IC1 pins 11 and 12, provide an adjustment which will be used to trim the timing period for best accuracy at the end of construction.

When IC1 pin 2 goes high at the end of the timing period, current flows into transistor TR1 base (b) through current limiting resistor, R5. This turns TR1 on and its collector (c) goes low. This low state is transferred to pin 2 (trigger input) of the 555 timer IC2.

TIMING

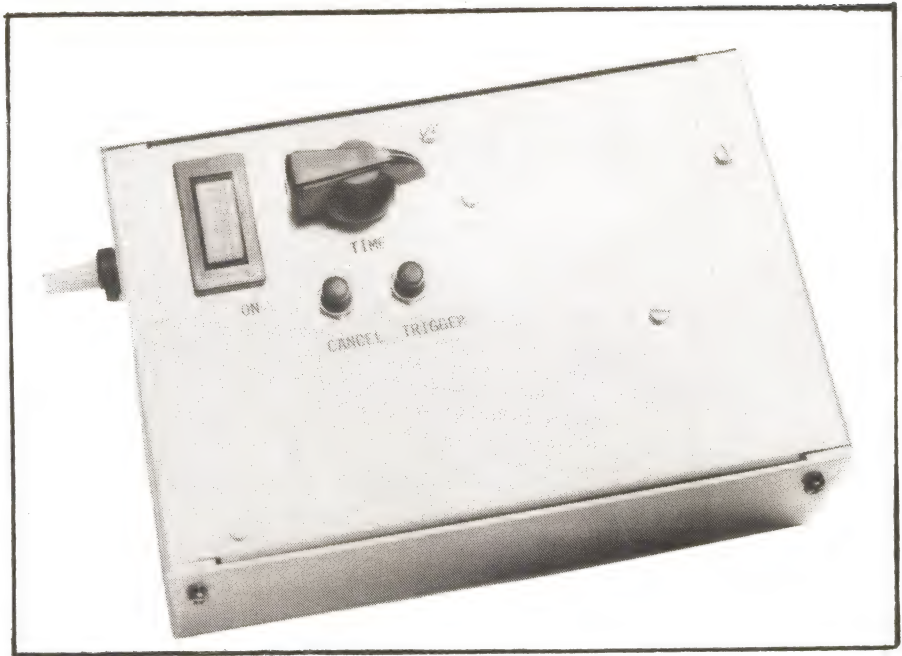
The Timer IC2 is connected as a mono-stable – that is, once triggered in this way the output, pin 3, goes high for a certain time then reverts to low. Between operations, IC1 pin 2 is low and transistor TR1 is off. IC2 pin 2 is then held high through resistor R6 and this prevents triggering.

The time period of IC2, during which the solenoid valve will be operating, depends on the adjustment of potentiometer VR2 in conjunction with fixed resistor R8 and capacitor C5. With VR2 providing minimum resistance the time period is less than one second but at maximum resistance, it is four minutes approximately.

Normally IC2 reset input, pin 4, is kept high through resistor R7 and this prevents resetting. However, pushbutton switch S2 (Reset) may be used to make it low and this cancels the operation immediately.

A further push-to-make switch, S1 (Trigger), may be used to initiate IC2 timing and operate the solenoid valve at any time. This it does by making IC2 trigger input, pin 2, low.

Note that the monostable timing capacitor, C5, is of the electrolytic type. This will not provide great accuracy but is thought to be quite satisfactory for the present purpose. For a longer operating time it could be increased in value.



At the end of IC1 ("daily") timing cycle, the low state of pin 3 is applied to pin 1 (the trigger input) through resistor R4 – this re-triggers the i.c. and initiates a further timing cycle. This process will repeat indefinitely until the supply is switched off.

SOLENOID VALVE

The output of IC2, pin 3, is incapable of supplying sufficient current to operate the solenoid valve SOL directly so, for this purpose, transistor TR2 is used as a simple current amplifier. When IC2 output, pin 3, goes high (positive supply voltage) current flows through resistor R9 into TR2 base and turns it on. Collector current now flows through the solenoid coil. This produces a magnetic field which pulls an

iron armature and actuates the water valve.

Diode, D1, connected in parallel with the solenoid coil bypasses the reverse high-voltage pulse which occurs when the current switches off and the magnetic field collapses. Without this, semiconductor components in the circuit could be destroyed.

POWER SUPPLY

Power for the circuit is obtained from a conventional arrangement of mains transformer, T1, on-board rectifier diodes, D2 and D3 and smoothing capacitor, C6. The fuse, FS1, in T1 secondary circuit, provides protection in case of component failure or short-circuit.

No voltage regulator is required for IC1 since this is provided on the chip in con-

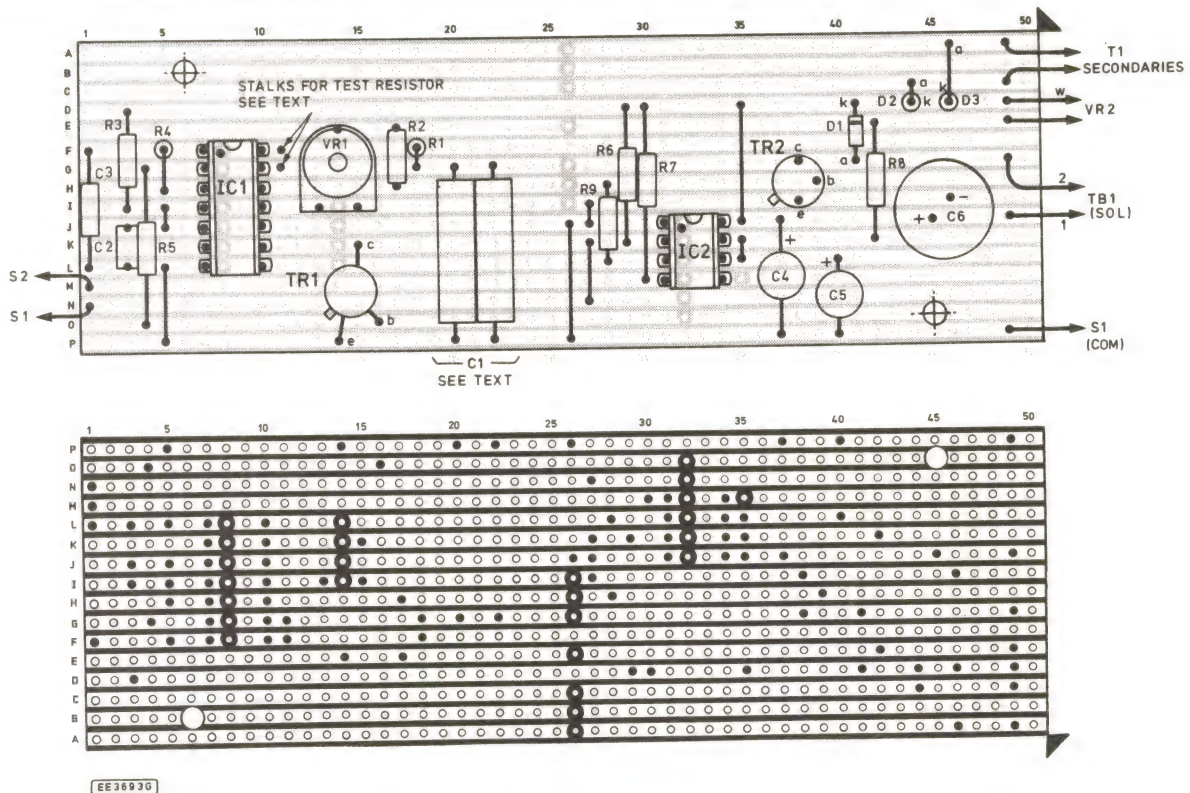


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks.

junction with resistor R3. Voltage regulation is not required for IC2 either because its timing is largely independent of the supply voltage. In any case, the exact value of the time period – that is, the time during which the hose operates – is not thought to be particularly critical.

Mains transformer T1 must have a generous current rating. This ensures cool and stable operation during continuous operation.

It also makes sure that the extra load of the solenoid valve does not cause problems due to sudden voltage drops. Do not use a transformer having an output rated at less than 500mA.

CONSTRUCTION

Safety Note: In constructing the Garden Hosepipe Controller, mains connections need to be made. Anyone who is not certain of being able to make a safe job must consult a qualified electrician.

In particular, the unit must be built in an

Earthed aluminium box and plugged into an adjacent supply using a plug fitted with a 2A fuse. If a fused plug is not used, a separate 1A or 2A mains-type fuse must be fitted in the transformer primary circuit.

Construction is based on a circuit panel made from a piece of 0.1in. matrix stripboard, size 16 strips × 50 holes. This carries most of the components. Topside component layout, details of underside track breaks and inter-strip links needed are shown in Fig. 2.

Drill the two fixing holes and mount all on-board components taking care over the polarity of diodes D2 to D3 and of electrolytic capacitors C4, C5 and C6.

In the case of the polyester capacitor C1, the specified value (4.4µF – 4.7µF) is higher than many suppliers stock. However, ample space has been left on the circuit panel for two 2.2µF polyester capacitors to be connected in parallel (see photograph). Additional capacitors could also be used to increase the time period.

Note the two short "stalks" or terminal posts to which test resistor Rx is connected temporarily – these consist of 10mm pieces of clipped-off resistor ends. The timing period of IC1 is shortened to approximately one minute by Rx and simplifies the testing and adjustment procedure.

Solder 10cm pieces of light-duty stranded connecting wire to copper strips D, E, G, J and P along the right-hand side of the circuit panel and to strips M and N on the left as indicated.

CASE AND INTERWIRING

In the prototype unit, all internal components were mounted on the base section of the case. This method imposes least strain on the interconnecting wires. It also means that the unit is easily attached to the wall if required.

Prepare the case by drilling holes for transformer T1 mounting, for switches S1,

S2 and S3, potentiometer VR2, fuseholder FS1 and terminal block, TB1. Drill holes also to align with the mounting holes already drilled in the circuit board.

Make holes for the solenoid valve output wire and for the mains input wire. Make sure these holes are large enough to accommodate the strain relief bushes to be fitted later.

Solder T1 secondary output wires to strips A and C on the board then, referring to Fig. 3, mount all internal components and complete the wiring (see photograph). Note the solder tag at one of the T1 fixing lugs. This will be used to Earth the transformer core and is an essential safety requirement – *do not use a makeshift method*. Note also that one of switch S1 terminals is a meeting point for several "earth" wires – make sure these are secure.

Mount the circuit board on 5mm long plastic stand-off insulators to keep the copper strips and soldered connections clear of the metalwork. Place a piece of cardboard between the circuit board and the box if necessary.

Insert the fuse into its holder. Fit VR2 control knob and adjust both VR1 and VR2 sliding contacts fully anti-clockwise (to provide minimum timings).

Make and fit the mains lead. This consists of a suitable length of 3-core mains-type wire of 3A rating minimum. Fit this through the hole drilled for the purpose using a strain relief bush – this will prevent it dislodging from On/Off switch S3 in service.

Connect the Live and Neutral wires to switch S3 – hook the wires through the holes and solder securely. Use a similar hooked connection to attach the Earth wire and the wire leading from S1 to the solder tag. These wires must be secure – especially the mains Earth one.

Prepare the solenoid valve connecting wire. This may consist of any light duty twin type such as bell wire. However, if the unit is to be sited some considerable distance from the water supply, it may need to be

COMPONENTS

Resistors

R1	4M7
R2	47k
R3	680
R4, R7	10k (2 off)
R5, R6	100k (2 off)
R8	4k7
R9	2k2
Rx	3k3 test resistor – see text

See
SHOP
TALK
Page

All 0.25W carbon film

Potentiometers

VR1	47k sub-miniature preset horizontal
VR2	2M2 rotary carbon, linear

Capacitors

C1	2µ2 polyester (2 off) or single 4µ7 – see text
C2, C3	100n ceramic (2 off)
C4	47µ radial elect. 16V
C5	100µ radial elect. 16V
C6	2200µ radial elect. 16V

Semiconductors

D1, D2, D3	1N4001 50V 1A rectifier diodes (3 off)
TR1	BC108 npn silicon
TR2	BFY51 npn silicon
IC1	ZN1034E timer
IC2	555 timer

Miscellaneous

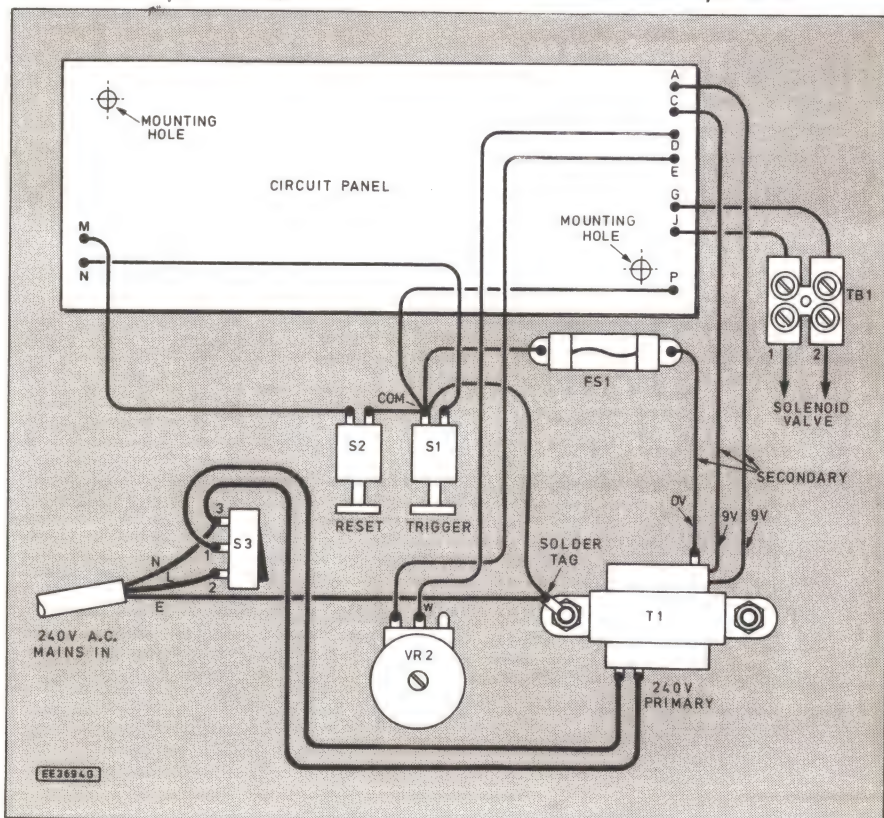
T1	Mains transformer with 240V primary and 9V-0-9V secondary (or two 9V secondaries) rated at 500mA minimum
S1, S2	Min. press-to-make, release-to-break push switch (2 off)
S3	Mains rocker switch with neon indicator
FS1	500mA 20mm fuse and chassis fuseholder
SOL	Mains-pressure water solenoid valve – 12V d.c. operation

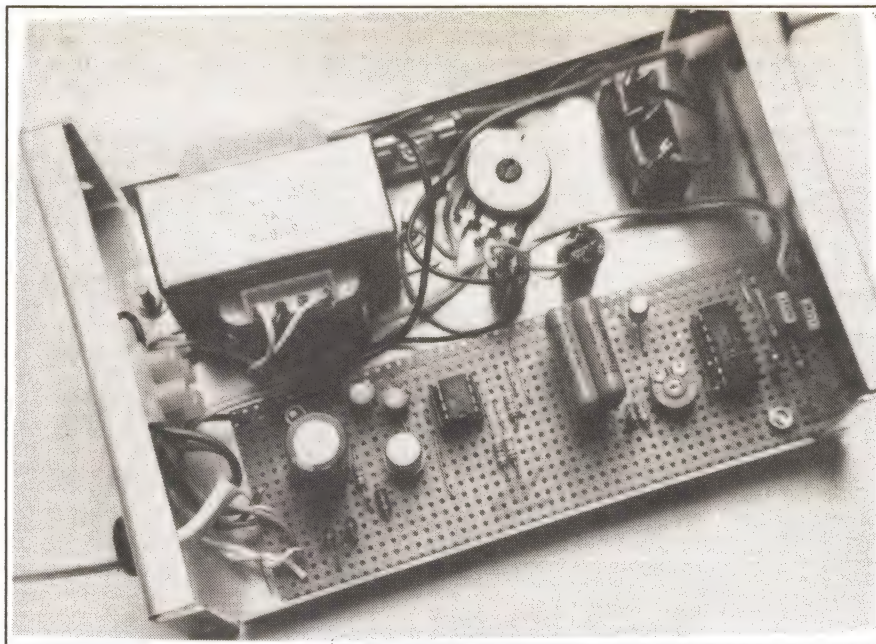
Stripboard 0.1in. matrix, size 16 strips × 50 holes; aluminium box, size 152mm × 102mm × 51mm; two-way terminal block; 8-pin d.i.l. socket; 14-pin d.i.l. socket; stand-off insulators (2 off); connecting wire; solder tags; solder etc.

Approx cost
guidance only

£26

Fig. 3. Interwiring from the circuit board to off-board components.





The complete circuit board mounted inside the metal case. The metal case must be "Earthed" through the mains lead, see Fig. 3.

thicker to prevent excessive voltage drop – loudspeaker wire, for example. Tests will reveal if this is necessary since on test the solenoid valve will operate sluggishly or not at all.

Fit one end of the wire with spade receptable connectors to fit those on the solenoid valve. Secure the other end using a strain relief bush and connect to TB1/1 and TB1/2 (polarity unimportant).

TESTING AND ADJUSTMENT

There are exposed mains connections at switch S3 inside the case. For safety reasons therefore, the box must be assembled whenever the unit is plugged in. Adjustments to VR1 are made in small steps with the lid replaced each time.

For testing, it will be found convenient to connect a small 12V bulb (2.2W rating) to the output wires in place of the solenoid valve. Plug the unit into the mains and switch on. It usually self-triggers and the lamp will light for one second or so. After one minute approximately, the lamp should light again and the process repeat indefinitely.

If the lamp remains on for a longer time it is possible that the incorrect outer (track) connection to the rotary potentiometer VR2 has been used. Check by rotating the control knob fully clockwise. If the circuit now behaves correctly, connect the wire leading

from strip E on the circuit panel to the other outer tag of VR2.

You will save time later by adjusting VR1 sliding contact clockwise in very small steps so that an operating time of one minute (within one second or two) is obtained. Rx may then be removed. IC1 time period will now be approximately one day.

Over a trial period, adjust preset VR1 slightly to provide a timing of 24 hours or as required. If the correct timing cannot be obtained even with VR1 at an extreme of its travel, resistor R2 will need to be increased to increase the timing and vice-versa.

By triggering the unit manually, rotary control VR2 could be calibrated and a scale of operating time in seconds marked out on the front panel. This was not thought worthwhile in the prototype.

EFFECT OF TEMPERATURE

This circuit is not designed to produce precise daily timings and maximum repeat accuracy will only be obtained if the temperature of the unit is kept reasonably constant. If the unit is situated in a centrally heated room where the temperature is thermostatically controlled, accuracy of a minute or two per day may be expected. IC1 itself introduces a daily timing error of up to 800ppm (parts per million) per degree – the timing falling with a rise in temperature.

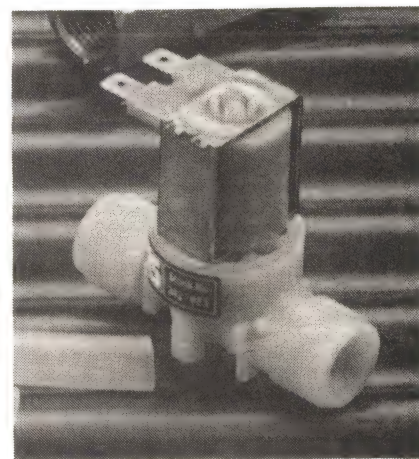
Capacitor C1, also introduces a tempera-

ture effect – using the specified polyester type this is typically 200ppm per degree. This is a positive coefficient – that is, capacitance rises with a rise in temperature. This is useful since it offsets the effect of IC1 itself to some extent.

Resistors R1, R2 and preset VR1 also introduce a small temperature effect. The final effect of temperature on timing error may be expected to be in the region of 1000ppm per degree maximum which corresponds to approximately 1½ minutes per degree in the finished circuit.

IN USE

Attach the unit to the wall if required. Remove the test lamp. Fit the solenoid valve to the water tap – note the arrow on the body which indicates the direction of water flow.



Low voltage mains-pressure water solenoid valve.

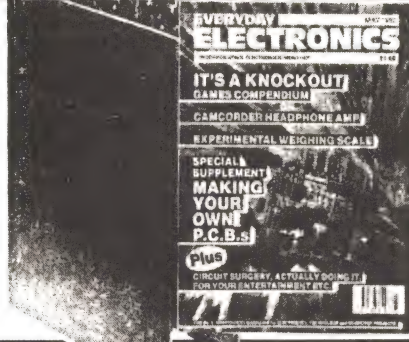
Connect the hosepipe. Attach the output wires. Turn the tap on and check for leaks.

Switch on the mains and if the unit does not self-trigger, press switch S1. The solenoid valve should operate and water issue from the hosepipe for a time set by control VR2.

If rain can reach the solenoid valve, remember to provide some protection to the terminals so that corrosion and consequently poor contact cannot occur. The Hosepipe Controller may now be put into service. Note that it is normal for the case to become slightly warm.

Remember to have a neighbour on call so that the unit may be switched off should a hosepipe ban be imposed by the local water authority. Remember also, that a licence may be required to use this type of device since it is not handheld – if in doubt, consult your local water company. □

EVERYDAY ELECTRONICS BINDERS

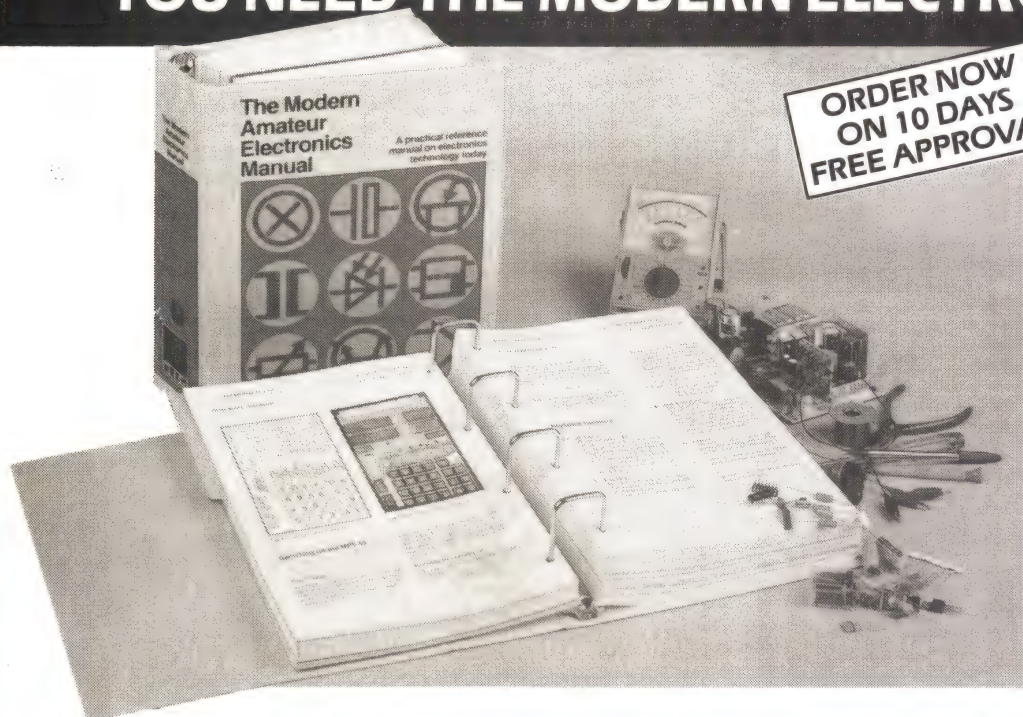


Don't let your valuable issues of EE get binned, burned or bitten (by the dog). Get one of our exquisite orange hard-back binders, slip each issue into it as you get them and you will always know where they are – we hope!

Binders to hold one volume (12 issues) are available from Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH for £5.95 (£6.95 to European countries and £8.00 to other countries, surface mail) inclusive of postage and packing. Payment in £ sterling only please.

Binders are normally sent within seven days of receipt of your order but please allow up to 28 days for UK delivery – more overseas.

WHETHER ELECTRONICS IS YOUR HOBBY OR YOUR LIVELYHOOD . . . YOU NEED THE MODERN ELECTRONICS MANUAL



ORDER NOW
ON 10 DAYS
FREE APPROVAL

The essential reference Work

- Easy-to-use format
- Clear and simple layout
- Regular updates
- Sturdy ring-binder
- News of latest developments
- Full components checklist
- Extensive data tables
- Detailed supply information
- Ready-to-transfer PCBs
- Comprehensive subject range
- Accurate assembly instructions
- Concise repair procedures

EVERYTHING YOU NEED TO KNOW ABOUT ELECTRONICS!

If the fascinating and fast-changing world of electronics is your livelihood, your study subject or simply your passion, the new revised edition of **THE MODERN ELECTRONICS MANUAL** is the reference work for you to have at your side.

The base manual contains information on the following subjects:

BASIC PRINCIPLES: symbols, components and their characteristics, passive component circuits, power supplies, acoustics and electroacoustics, the workshop, principles of metrology, measuring instruments, digital electronics, operational amplifiers, timers, physics for electronics.

CIRCUITS TO BUILD: construction techniques, radio, telephony, microcomputing, measuring instruments, vehicle electronics, security, audio, power supplies, electronic music (over 25 different projects).

REPAIRS AND MAINTENANCE: radio, television, audio/hi-fi, telephones.

DATA: diodes, transistors, thyristors and triacs, digital and linear i.c.s, microprocessors.

The manual also covers **Safety, Specialist Vocabulary with Abbreviations and Suppliers.**

OVER 1,000 pages, A4 format weighing over 3.5kg.

Now – at last – the most comprehensive reference work ever produced at a price you can afford, the new revised edition of **THE MODERN ELECTRONICS MANUAL** provides you with all the essential information you need.

Over 1,000 pages of well-organised and clearly explained information is brought to you by an expert editorial team whose combined experience ensures the widest coverage.

Regular supplements to this unique publication, each around 160 pages, mean that you will always be kept abreast of the latest developments from the UK, USA and Europe as they occur

ALL-IN-ONE AND EASY-TO-USE

A sturdy ring-binder allows you to use the manual on your workbench. The looseleaf format also means you can slot in the regular updates as they arrive – so all your information is there at a glance.

EXTENSIVE GLOSSARY

Should you come across a technical word, phrase or abbreviation you're not familiar with – simply turn to the glossary included in the manual and you'll find a comprehensive definition in plain English.

REGULAR UPDATES

Unlike a book or encyclopedia, the manual is a living work – continuously updated by new material. Recent or upcoming supplements include radio, superconductors, electric motors, basic electronic building blocks for beginners which can be joined together to construct elaborate circuits, filters, IBM PC and compatibles (including use of PC cards). Supplements are sent to you approximately every two months.

Each supplement contains approximately 160 pages – all for only £23.50 + £2.50 p&p. You can of course return any supplement which you feel is superfluous to your needs.

RESPONDING TO YOUR NEEDS

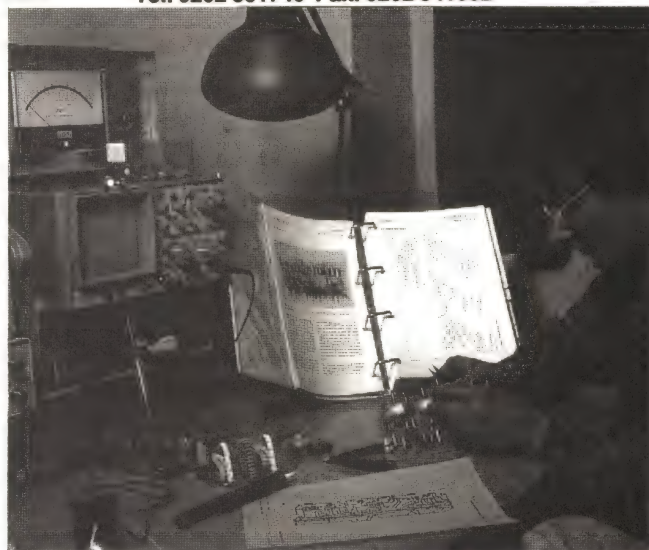
We are able to provide you with the most important and popular articles in our updating supplements. Our unique updating system is based on answers from readers request questionnaires. Through this service you are able to let us know exactly what information you require in your manual. You can also contact the editor directly in writing if you have a specific technical request or query relating to the manual.

ASSEMBLING ...

There's nothing to beat the satisfaction of creating your own project. From basic principles to circuit-building, the manual describes clearly, with appropriate diagrams, how to assemble radios, loudspeakers, amplifiers, micro-computers and measuring instruments.

The new revised edition of The Modern Electronics Manual contains practical, easy-to-follow instructions for building and programming your own computer. It shows you how to make fun gadgets such as a remote control door opener and a digital rev. counter for your car. It also tells you how to construct useful devices like test gear, security and baby alarms – plus – many more popular devices.

Wimborne Publishing Ltd., 6 Church St, Wimborne, Dorset BH21 1JH
Tel: 0202 881749 Fax: 0202 841692



THE MODERN ELECTRONICS MANUAL

New Revised Edition of Basic Work: Now contains over 1,000 pages of information.

Regular Updates: Approximately 160-page supplements of additional information which are forwarded to you immediately on publication. These are billed separately and can be discontinued at any time.

Presentation: Durable looseleaf system in large A4 format (197mm × 210mm)

Price of the Basic Work: £39.95 + £5.50 p&p (to include a recent supplement).

YES please send me on 10 days free approval **THE MODERN ELECTRONICS MANUAL**. If I decide to keep the manual, I shall then pay **only £39.95** plus £5.50 postage and packing at the end of the 10 days approval period. I shall also receive the appropriate Updating Supplements several times a year. These are billed separately and can be discontinued at any time.

FULL NAME
(PLEASE PRINT)

ADDRESS.....

..... POSTCODE

I AM OVER 18

SIGNATURE.....

ORDER FORM

Simply complete and return the order form to the following address

**The Modern
Electronics Manual**
Wimborne Publishing Ltd
6 Church Street
Wimborne Dorset BH21 1JH

OVERSEAS ORDERS: All overseas orders **must be prepaid** but are supplied under a money-back guarantee of satisfaction. If you are not entirely happy with the manual return it within a month for a refund of the purchase price (you do have to pay the postage). **Add** the following amounts to the price of the manual to cover postage:

EIRE £10.00.

EUROPE (Including C.I.S.) £19.00.

REST OF THE WORLD £24.00.

Note these prices are for airfreight, each manual weighs over 3.75kg when packed – we do not supply overseas by any other means. All payments must be made in £'s Sterling payable to Wimborne

INTERFACE

Robert Penfold



THE subject of bar codes is one which seems to crop up in reader's letters from time to time. Judging from letters I have received, and some I have seen published in various magazines, there seems to be a few misconceptions about the precise way in which bar codes operate. Before proceeding further it would perhaps be as well to dispel one or two myths.

Code Cracking

Many people seem to think that bar codes carry a lot of information. For example, if you read the contents of a bar code on a can of baked beans, the common belief is that you would get something along the lines of "Heinz Baked Beans, 225g, 38p". This seems reasonable, because reading the bar code into a supermarket checkout system would result in this sort of information being displayed, and printed on the receipt.

In reality matters are not as simple as this, and a do-it-yourself system that will provide a similar function is not a very practical proposition. The problem is that the bar code only provides detailed information in an indirect fashion, and it is not readable straight from the code. If you look at a bar code it will normally be accompanied by a long number (usually eight or thirteen digits long). There is a bar code plus thirteen digit number on the front of this copy of *Everyday Electronics*.

When a bar code is read, all that is fed into the computer system is this same number. Thus, if the bar code becomes damaged and cannot be read, the number can be typed into the system by hand. This quite often has to be done at supermarket checkouts, as many readers will no doubt have noticed.

Look-up

So how is the detailed information extracted from the multi-digit code number? It is apparently done in quite a crude fashion, using a look-up table. There are actually large telephone directory style books which contain details of standard bar codes. Using one of these you can look up the code number on a can of beans, magazine, or whatever, and the relevant entry will give the string of text for that particular code.

Using a bar code reader and a suitable computer system greatly speeds things up of course, and the books of codes are presumably only needed for reference and checking purposes. The basic method for extracting the detailed information is much the same though. The code number is read into the computer, and then the text string for that number is read from the computer's data base. Without this

massive data base, all you read in from the bar code is a meaningless number.

This is a good way of doing things in that it enables what is effectively a limitless number of different codes to be used, with as little or as much data as desired being attached to each code. The data associated with each code number can be as small as a price such as "38p", or 100,000 words of text. The upper limit on the amount of data is set by the database that has to handle it all, rather than by the bar code system.

The system is less satisfactory in that you can only extract meaningful information from a bar code if you have a computer equipped with a suitable decoding system and database. This makes it rather impractical to implement a home produced system that can read bar codes from everyday products and provide the appropriate string of text. Reading bar codes into the system is a practical proposition, but the database side of things is not.

Being realistic about it, a bar code system that would directly provide text strings is not a very practical proposition. Even a simple price such as "38p" would require three seven bit ASCII codes, or some 24 bits in total. Adding a product description would require hundreds more bits to be included. Bar codes hundreds of bars in length are not usable in most practical situations. The look-up system may be an inconvenient one, but it is perfectly usable.

DIY Bar Codes

While reading commercial bar codes and displaying the relevant information is not a very practical proposition for the home user, this is not to say that do-it-yourself bar codes are totally impractical. It is quite possible to use your own system of bar codes if you can come up with a suitable application. Bar codes are not restricted to supermarket stock style applications. One of the more imaginative commercial applications is in certain Canon EOS cameras which have an optional bar code reader and a book of pictures. Each picture is, of course, accompanied by a bar code.

The basic idea is that you look through the book until you find a picture that is of the type you are going to take, and you then read the accompanying bar code into the camera. Its programmed exposure system then sets the most suitable shutter speed and aperture under the prevailing circumstances. If you are taking some sort of action shots for instance, the camera will set fast shutter speeds (to freeze the action) and use wide apertures if the light level is indifferent.

Such a feature is clearly a waste of time if you are a reasonably expert photographer (and there is no bar code reader input on the professional EOS models), but it helps the non-expert to get good results. Another use of bar codes is in security applications, and there must be many other novel uses for them.

Software

There are programs available for some computers that will print out various sizes and types of bar code. There is at least one set of shareware bar code generator programs available for the IBM PCs, and you should find this set listed in any of the larger PC shareware catalogues (but note that the output is only suitable for Epson 9-pin and true Epson 9-pin compatible printers). Reading the bar codes is more difficult, since this type of software only seems to be sold as part of a complete bar code reader and software package.

The do-it-yourself bar code user therefore has to write his or her own reader software. Of course, you do not have to do things one of the standard ways if a system is only for your own use, and compatibility with someone else's bar code system is not needed. Indeed, it is probably more practical not to do things the standard way as this avoids what is likely to be severe over-kill for do-it-yourself applications.

Implementing a practical bar code system is slightly more difficult than you might think, as anyone who saw one of the early commercial systems in operation will no doubt have realised. Quite a high percentage of bar codes could only be read in after several attempts, and a not insignificant percentage simply would not read in at all. Modern readers are very much better, but they use some expensive technology which goes beyond the scope of do-it-yourself projects. However, it is possible to obtain quite good results from simple systems.

Practical Matters

It is not too difficult to devise a simple but practical bar code system, but there are a few important factors to bear in mind. One of these is that there will inevitably be widely differing reading speeds. Each user will wave the "pen" over the bar code at a different speed, and there may well be significant variations each time the same person uses the system. The way around this problem is to use a relative rather than an absolute approach to reading the bars.

A binary number can easily be coded into the bars by using narrow bands for 0s and wide bands for 1s (or vice versa).

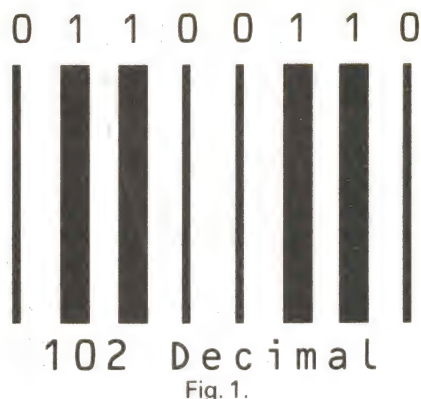


Fig. 1.

Fig. 1 shows how an eight bit binary number can be bar coded using this system. Reading the bars on the basis of narrow bars being below a certain read time, and wide bars being above it, will not work very well. Anyone "waving" the reader slightly too fast or too slow will produce all 0s or all 1s.

A better method is to measure the time taken for the full code to be read in. This is then divided by an apposite amount to produce the threshold time that is used to distinguish between the 1s and 0s. The threshold time is therefore automatically raised or lowered to compensate for the reader being swept to slowly or too quickly.

Although this may at first seem to be an absolute method of reading the bar widths, it is actually reading the widths of the bars relative to the total width of the bar code. This gives much better reliability than a truly absolute method.

Implementing a system of this type in hardware is far from straightforward, but

it is easily implemented in computer software. It will give good reliability in general, but it will not cope with variations in sweep speed while a code is being read. It should be possible to detect and compensate for this using "intelligent" software routines, but this would seriously complicate the software.

It is better if this problem can be avoided by having the operators work the system properly. It is really not too difficult to wave the reader at a reasonably constant speed while it is over the bar code.

Refinements

It is possible to add a couple of useful refinements to the basic system if desired. One possibility is to have start and finish codes. The idea of this is to enable the system to detect whether or not the bar code has been read the right way round, or in reverse. If a reversed code is detected, the system can automatically invert it to produce the right result.

Another useful refinement is to add error checking. This type of thing is usually implemented using some form of checksum system. The basic idea is to have one or more extra digits in the code. When the main code is mathematically processed in some way, this gives an answer equal to the additional number. If when the main code is read in it becomes scrambled, this will prevent the right checksum value from being obtained, even if only one binary digit has been affected. This can be detected using a software routine which would alert the user to the fact that the code had not been read correctly. A fresh attempt can then be made.

Resolution

Using a relative system of bar code decoding means that, for once, size really is not important. In theory, you can scale the bar code up as large as you like, or make it as small as necessary. Provided the relative widths of the bars are unaltered, the code can be read properly. In practice matters are not as simple as this, and there is the resolution of the reader to be taken into account.

The widths of the lines on commercial bar codes are mostly quite small. There are actually exceptions to this, and bar codes on warehouse containers are usually "Jumbo" sized. This is so that they are easy to find on the large boxes. Obviously it is not practical to have large bar codes on small products such as tins of peas. This results in some bar codes that have very narrow bands.

If you make some measurements on the bar code on the front of this magazine you will find that the wide bars are actually less than one millimetre wide. The narrow bars are only a fraction of a millimetre wide. To read in such a small bar code successfully requires a very high degree of resolution. In fact it requires special sensors that are difficult to obtain, and quite expensive.

For the do-it-yourself bar code user it is best to settle for a narrow bar that is at least one millimetre thick. This still enables reasonably compact bar codes to be used, but keeps the reading process easy enough for inexpensive sensors to be used successfully.

Next month some practical bar code hardware and software will be described.

SHOP TALK

with David Barrington

Garden Hosepipe Controller

All components required to build the *Garden Hosepipe Controller* are standard items except the 12V d.c. operation mains pressure solenoid valve.

The water valve used in the prototype model was purchased through **Electromail** (☎ 0536 204555), order code 342-023. It is quite possible a local plumbing supplies shop may stock a suitable solenoid valve. They will also be able to supply the coupling connectors.

A couple of points to remember: A metal case must be used and be soundly "earthed" to the mains earth lead. The mains transformer used must have a generous current rating and **must not** be less than specified. Make sure you site the water solenoid in a position which, should there be a breakdown, any possibility of flooding will not do any damage.

Finally, the unit must not be *permanently* connected to the mains power supply. Also, please comply with any hosepipe ban imposed by the local water company.

UV Exposure Timer

It is best to use only the specified mains transformer and relay when constructing the *UV Exposure Timer*. This will ensure that these components fit on the p.c.b.

The ones used in the model were purchased from **Farnell Electronic Components** (☎ 0532 636311), code 149-975 (Mains Tran.) and from **Maplin**, code YX97F (Ult.-Min. 10A Mains Rly).

A suitable Euro-style safety plug and socket would be from the Bulgin range. This range is stocked by most of our component advertisers.

The case was obtained from **Verospeed** (☎ 0703 644555) and is from their Apollo 3 range, code 75-39242A. The printed circuit board is available from the *EE PCB Service*, code EE797 (see page 467).

Cricket Game

The only component that can be classed as special amongst the items required to build the *Cricket Game* is the relay. The rest of the parts are standard "off-the-shelf" lines.

Once again the use of the specified relay is because it must sit directly on the printed circuit board and connect to the correct copper solder pads on the underside of the board. The relay was obtained from **Electromail** (☎ 0536 204555), order code 350-557.

Other relays can, of course, be used provided they have identical pinout configura-

tions and electrical characteristics. The relay could also be mounted separately inside the case and "hard wired", using insulated leads, to the circuit board.

If contemplating building the suggested mains power supply, a suitable transformer would be a 3VA type, either single 12V or two times 6V secondaries. Any similar p.s.u. can be used as long as it is capable of an output voltage of between 7.5V and 9V at 100mA. The specified transistor should have a clip-on type heatsink.

The Cricket Game printed circuit board is available from the *EE PCB Service*, code EE798 (see page 467).

Quick Prom

The zero insertion force (ZIF) socket called for in the *Quick Prom* should be widely available and prices range from about £6 to £7.

The MK48Z02B-25 static RAM (SRAM), with integral lithium battery, is not such a common device and may not be available locally. However, a complete kit, (£27 all inclusive), including the SRAM, is available from **Becker Systems, Dept EE, 8 Finucane Drive, Orpington, Kent, BR5 4ED**.

The printed circuit board for the *Quick Prom* is available from the *EE PCB Service*, code EE799.

Class-A Headphone Amplifier

We cannot foresee any component buying problems ahead for constructors wishing to build the *Class-A Headphone Amplifier*. When ordering parts remember its important to specify "log" type potentiometers.

BARGAINS GALORE

SUPER MULTIMETER Ex British Telecom, this is a 19-range 20k o.p.v. top grade instrument, covers AC & DC voltages, current and resistance, very good condition, fully working and complete with leads £9.50, leather carrying case £2 extra (batteries not included but readily available).

MULTI-CORE CABLES all with 8A 230V cores so suitable for disco and other special lighting effects. With earthable woven screen and thick pvc outer. 3 core, 30p per metre, 16 core, 50p per metre, 18 core, 80p per metre, 25 core, £1 metre and 36 core, £1.50 per metre.

VOLTABLOCK an infinitely variable unit gives any voltage from 0-230 a.c. at 1/2A. Obviously an invaluable piece of equipment which should be in every workshop and probably would be except that the usual price for this is £35 plus VAT. Now is your chance to buy one, brand new, at £15 including VAT, Order Ref. 15P42B.

ULTRA THIN DRILLS Actually 0.3mm. To buy these regular costs a fortune. However, these are packed in half dozens and the price to you is £1 per pack, Order Ref. 797B.

YOU CAN STAND ON IT! Made to house GPO telephone equipment, this box is extremely tough and would be ideal for keeping your small tools. Internal size approx. 10 1/2" x 4 1/2" x 6" high. These are complete with snap closure lip and shoulder-length carrying strap. Taken from used equipment but in good condition, price £2, Order Ref. 2P283B.

BUILD YOUR OWN NIGHT LIGHT, battery charger or any other gadget that you want to enclose in a plastic case and be able to plug into a 13A socket. We have two cases, one 3 1/2" x 2 1/4" x 1 3/4" deep, £1 each, Order Ref. 845. The other one is 2 1/2" x 2 1/4" x 1 3/4" deep, 2 for £1, Order Ref. 565.

SAFETY LEADS curly coil so they contract but don't hang down. Could easily save a child from being scalded. 2 core, 5A, extends to 3m, £1, Order Ref. 846. 3 core, 13A, extends to 1m, £1 each, Order Ref. 847. 3 core, 13A, extends to 3m, £2 each, Order Ref. 2P290.

POWER SUPPLY WITH EXTRAS mains input is fused and filtered and the 12V dc output is voltage regulated. Intended for high class equipment, this is mounted on a PCB and, also mounted on the board but easily removed, are 2 12V relays and a Piezo sander, £3, Order Ref. 3P80B.

5V 2.5A POWER SUPPLY UNIT £5, Order Ref. 5P186.

12V 1.9 AMP-HOUR a sealed lead-acid battery, charged ready for use £5.50, Order Ref. 5.5P/1.

100W MAINS TRANSFORMER normal primary 20-0-20 at 2.5A, £4, Order Ref. 4P59. 50 V at 2A, £4, Order Ref. 4P60. Or, instead of 20-0-20, this same transformer will deliver 30V at 3.5A.

PHILIPS 9" HIGH RESOLUTION MONITOR black & white in metal frame for easy mounting, brand new still in maker's packing, offered at less than price of tube alone, only £15, Order Ref. 15P1.

16 CHARACTER 2-LINE DISPLAY screen size 85mm x 36mm, Alpha-numeric LCD dot matrix module with integral micro processor made by Epson, their Ref. 16027AR, £8, Order Ref. 8P48.

INSULATION TESTER WITH MULTIMETER internally generates voltages which enable you to read insulation directly in megohms. The multimeter has four ranges. AC/DC volts, 3 ranges DC milliamps, 3 ranges resistance and 5 amp range. These instruments are ex British Telecom but in very good condition, tested and guaranteed OK, probably cost at least £50 each, yours for only £7.50, with leads, carrying case £2 extra, Order Ref. 7.5P/4.

BRUSHLESS DC 12V FAN tiny, only 60mm square, good air mover but causes no interference, £8, Order Ref. 8P26.

MAINS 230V FAN best make "PAPST" 4 1/2" square, metal blades, £8, Order Ref. 8P8.

2MW LASER Helium neon by Philips, full spec. £30, Order Ref. 30P1. Power supply for this in kit form with case is £15, Order Ref. 15P16, or in larger case to house tube as well £18, Order Ref. 18P2. The larger unit, made up, tested and ready to use, complete with laser tube £69, Order Ref. 69P1.

1/3 HP 12V MOTOR - THE FAMOUS SINCLAIR C5 brand new, £15, Order Ref. 15P8.

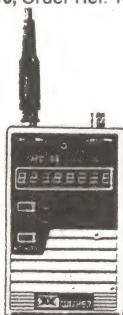
SOLAR CHARGER holds 4 AA nicads and recharges these in 8 hours, in very neat plastic case, £6, Order Ref. 6P3.

SOLAR CELLS with terminals for joining in series for higher volts or parallel for extra current: 100mA, £1, Order Ref. 361, 400mA, £2, Order Ref. 2P199, 700mA, £3.00, Order Ref. 3P42. 1A, £3.50, Order Ref. 3.5P/4.

AIR SPACED TRIMMER CAPS 2-20 pf ideal for precision tuning UHF circuits, 4 for £1, Order Ref. 818B.

FIELD TELEPHONES just right for building sites, rallies, horse shows, etc., just join two by twin wire and you have two way calling and talking and you can join into regular phone lines if you want to. Ex British Telecom in very good condition, powered by batteries (not included) complete with shoulder slung carrying case, £9.50, Order Ref. 9.5P/2.

MAINS ISOLATION TRANSFORMER stops you getting "to earth" shocks. 230V in and 230V out. 150watt upright mounting, £7.50, Order Ref. 7.5P/5 and a 250W version is £10, Order Ref. 10P79.



DIGITAL FREQUENCY METER.

This is a hand-held instrument with an LCD display allowing 8 digits of frequency to be read, has internal nicad batteries, and a power supply which will recharge the batteries. Ideal for field and service work as well as general and industrial applications. Has high and low BNC inputs and a plug-in antenna which enables remote tests. It covers a very wide range of frequencies: switch position 'A' covers 10Hz to 20MHz and switch position 'B' covers 20MHz to 1200MHz. Price £99, but it compares very favourably with instruments selling at over £500 by our competitors. Order Ref. 99P2.

MINI MONO AMP on PCB. Size 4" x 2" with front panel holding volume control and with spare hole for switch or tone control. Output is 4 watt into 4 ohm speaker using 12V or 1 watt into 8 ohm using 9V. Brand new and perfect, only £1 each, Order Ref. 495.

SRPM MAINS DRIVEN This is a shaded pole motor, £5, Order Ref. 5P54.

POWER SUPPLY UNIT mains in, dc out, cased 4.5V 100mA, £1, Order Ref. 104, 6V 200mA £1, Order Ref. 103, 6V 700mA, £1, Order Ref. 103A, 9V 500mA, £2, Order Ref. 2P134, 24V 200mA, £2, Order Ref. 2P4, 12V 2A, £6, Order Ref. 6P23.

AMSTRAD POWER UNIT 13.5V at 1.9A encased and with leads and output plug, normal mains input £6, Order Ref. 6P23.

AMSTRAD 3.5 FLOPPY DRIVE brand new and cased, £35, Order Ref. 35P4.

FREE

with orders this month one year's subscription to our bi-monthly newsletter. You will be the first to hear of our new lines!

ATARI 64XE at 65K this is quite powerful, so suitable for home or business, unused and in perfect order but less PSU, only £19.50, Order Ref. 19.5P/5B.

80W MAINS TRANSFORMER two available, good quality, both with normal primaries and upright mounting, one is 20V 4A, Order Ref. 3P106 the other 40V 2A, Order Ref. 3P107, only £3 each.

PROJECT BOX size approx 8" x 4" x 4 1/2" metal, sprayed grey, louvred ends for ventilation otherwise undrilled. Made for GPO so best quality, only £3 each, Order Ref. 3P74.

12V SOLENOID has good 1/2" pull or could push if modified, size approx 1 1/2" long x 1" square, £1, Order Ref. 232.

WATER VALVE 230V operated with hose connections, ideal for auto plant spray or would control air or gas into tanks etc., £1 each, Order Ref. 370.

HANG-UP 'PHONE won't clutter up your desk or workbench, current model, has push button dialling, last number recall, internal alarm etc. Ex B.T. in good condition and fully working ready to plug in, £5, Order Ref. 5P123.

ELECTRONIC BUMP & GO SPACESHIP sound and impact controlled responds to claps and shouts and reverses or diverts should it hit anything! Kit with really detailed instructions, will make ideal present for budding young electrician. Should be able to assemble but you may have to help with the soldering of the components on the PCB. Complete kit £8.95, Order Ref. 9P9.

500V BRIDGE MEGGER developed for GPO technicians the Ohmster 18B is the modern equivalent of the bridge megger. 9V battery operated, it incorporates a 500V generator for insulation testing and a null balance bridge for very accurate resistance measurement. Ex B.T. in quite good condition with data & tested. Yours for a fraction of original cost, £45, Order Ref. 45P2.

EXPERIMENTING WITH VALVES don't spend a fortune on a mains transformer, we can supply one with standard mains input and secs. of 250-0-250V at 75mA and 6.3V at 3A. £5, Order Ref. 5P167.

15W 8 OHM 8" SPEAKER & 3" TWEETER made for a discontinued high quality music centre, gives real hi-fi, and only £4 per pair, Order Ref. 4P57.

CLEAR THAT SMOKE according to a 'Which' report, many ionisers available from chemists and similar have such a poor output that they are next to useless. Our ioniser kit, however, uses mains transformers and is so powerful you can feel the ion output on the back of your hand and it will clear smoke in seconds. Complete, cased kit, price £16, Order Ref. 16P5.

ULTRASONIC TRANSMITTER RECEIVER with Piezo alarm, built into preformed case, is triggered by movement disturbing reflected signal, intended for burglar alarm, car alarm etc. has many extras, time delay, auto reset, secret 'off' device, etc. A £40 instrument, yours for £10, Order Ref. 10P76.

STEREO HEADPHONES extra lightweight with plug, £2 each, Order Ref. 2P261.

BT TELEPHONE LEAD 3m long and with B.T. flat plug ideal to make extension for phone, fax, etc. 2 for £1, Order Ref. 552.

WATER PUMP very powerful with twin outlets, an ideal shower controller, mains operated, £10, Order Ref. 10P74.

STUDIO 100 by Amstrad, the ultimate disco control panel, has four separately controlled and metered channels, twin cassettes, AM/FM radio, stereo audio amplifier, phono & CD inputs, etc., etc., regular price over £400, we have a few still in maker's packing, brand new and guaranteed, yours for £99, Order Ref. 99P1.

0-1MA FULL VISION PANEL METER 2 1/2" square, scaled 0-100 but scale easily removed for re-writing, £1 each, Order Ref. 756.

VU METER illuminate this from behind becomes on/off indicator as well, 1 1/2" square, 75p each, Order Ref. 366.

EDGE-WISE PANEL METER ideal when short of panel space only 40 x 14mm, also have built-in led, 500µA f.s.d., scaled 0-5, £1 each, Order Ref. 131.

PCB DRILLS 12 assorted sizes between .75 and 1.5mm, £1 the lot, Order Ref. 128.

JUST ARRIVED

3 core 15A flex. Price is 10m for £2.50, Order Ref. 2.5P/3. You can have this in longer lengths, multiples of 10m up to 100m. Also available: 3 Core 20A flex, 10m for £3, Order Ref. 3P109 and 2 core 20A flex, 15m for £3, Order Ref. 3P110.

Prices include V.A.T. Send cheque/postal order or ring and quote credit card number. Add £3 post and packing. Orders over £25 post free.

M & B ELECTRICAL SUPPLIES LTD

12 Boundary Road, Hove, Sussex BN3 4EH

Telephone (0273) 430380

Fax or phone (0273) 410142

DOWN TO EARTH

George Hylton

DISTORTION happens when output is not strictly proportional to input. In an audio amplifier, the kind of distortion which causes severe problems is harmonic distortion. A "pure" signal in the form of a perfect sine-wave contains only one frequency, the fundamental and no multiples of it (harmonics).

If the sine wave is distorted, harmonics are generated. This leads to a simple way of stating the amount of distortion: as the ratio of harmonics to fundamental.

Harmonic distortion is usually expressed as a percentage. Total harmonic distortion is sometimes expressed as the sum of all the harmonic power expressed as a percentage of the fundamental power.

In very bad cases this leads to the curious result that the distortion is more than 100 per cent. A more reasonable figure is given by comparing distortion with total power; i.e. with fundamental plus distortion.

Distortion Factor

In practice total harmonic distortion is not easy to measure, especially when small. One thing that blurs the picture is noise. All amplifiers generate noise. If the level of distortion is very low it is difficult to separate distortion from noise.

This has led to an alternative way of stating amplifier performance: compare the distortion plus noise with the total output. This gives a "distortion factor":

Distortion Factor = (Distortion plus noise)/(Fundamental + distortion + noise). Again this is usually expressed as a percentage.

For moderate levels of distortion (such as five per cent) the distortion factor is virtually the same as total harmonic distortion. For very low distortion the distortion factor is higher because noise becomes comparable with harmonics.

Measurement Systems

There are several ways of measuring distortion. A common scheme is shown in Fig. 1. The amplifier (or the circuit) under test is driven by a sine-wave system of great purity (i.e. virtually no harmonic content). The input is adjusted to set the output to some standard level

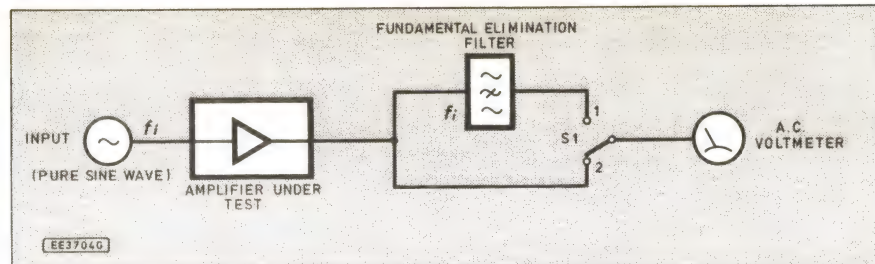


Fig. 1. Distortion factor measurement setup.

(such as the rated output power). A sharp filter giving infinite attenuation of the fundamental is connected. This allows harmonics and noise to pass freely. With switch S1 in position 1 the distortion-plus-noise is measured. In position 2 the total output is measured.

Comparing the measurements gives the distortion. Strictly speaking, the voltmeter should give true r.m.s. measurement. The distortion is really proportional to power rather than voltage. Sometimes the distortion is given as a decibel figure: if the distortion voltage is one thousandth of the fundamental voltage the distortion is -60dB, i.e. 60dB down on the fundamental.

Fundamental Filter

Eliminating the fundamental is not easy. A distortion of 0.1 per cent means that the harmonic power is 60dB down. A filter which attenuates the fundamental by 60dB still allows as much fundamental to get through as distortion, giving an exaggerated distortion figure. Modern amplifiers may have distortion levels as low as 80dB below fundamental, or even lower. Filters of exceptionally good performance are needed. However, they need only eliminate one single frequency. This eases the problem, because a number of circuits exist which give a complete null at one frequency.

The Twin-T network of Fig. 2 gives zero output at the frequency where the reactance of C is equal to the resistance R , but attenuates the lower harmonics to some extent. For good results the tolerance of the components must be very tight. More sharply tuned is the Bridged-T trap (Fig. 3), which eliminates signals at the resonant LC frequency when R is correctly adjusted.

Spectrum Analysis

An alternative way of examining harmonic distortion is to display the total spectrum of frequencies on an oscilloscope (Fig. 4). Incoming harmonics applied to the modulator give an output pulse when the sweep frequency coincides with the harmonic frequency.

If the oscilloscope timebase is synchronised to the frequency-sweep control waveform the display shows successive harmonics as blips. The height

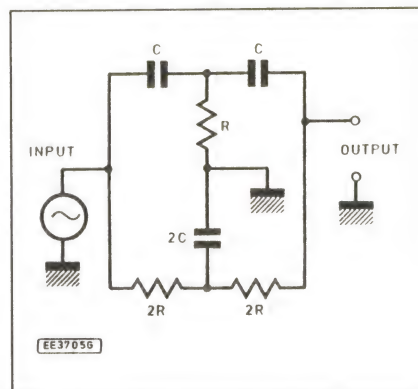


Fig. 2. Twin-T network.

of a blip shows the intensity of the harmonic.

The system is much used for radio-frequency investigations but in principle is applicable at audio frequencies too. The sweep rate must be very low and an ordinary scope cannot then give a steady display.

Intermodulation

A consequence of some forms of harmonic distortion is that a strong signal modulates a weak one. In spectral terms this means that new frequencies are generated, the main ones being the sum of the strong and weak frequencies and their difference. Thus a strong 400Hz signal and a weak 1000Hz one intermodulate to yield 600Hz and 1400Hz. Since these frequencies are not present at the input they are distortion products.

It is arguable that intermodulation gives a better indication of audio quality than total harmonic distortion, since its use of simultaneous signals on different

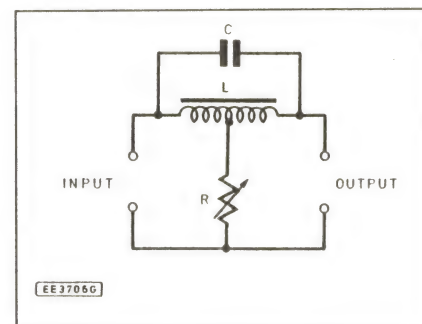
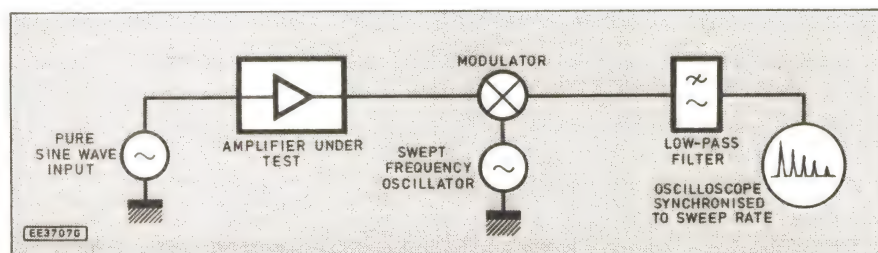


Fig. 3. Bridged-T trap.

Fig. 4. Spectrum analysis.



frequencies mimics speech and music to some extent.

A particularly simple technique for intermodulation measurement has been evolved by telephone engineers. In a wide-band multichannel carrier telephone link the presence of many different speech signals can be simulated quite closely by white noise, which is an equal mixture of all frequencies.

To test such a wide-band network (Fig. 5), the output of a white noise generator is passed through a notch filter which cuts a slot in the spectrum at a narrow band of frequencies around f_s . Thus the signal applied to the system contains all possible frequencies except f_s . Intermodulation in the system causes spurious signals (distortion) at f_s to ap-

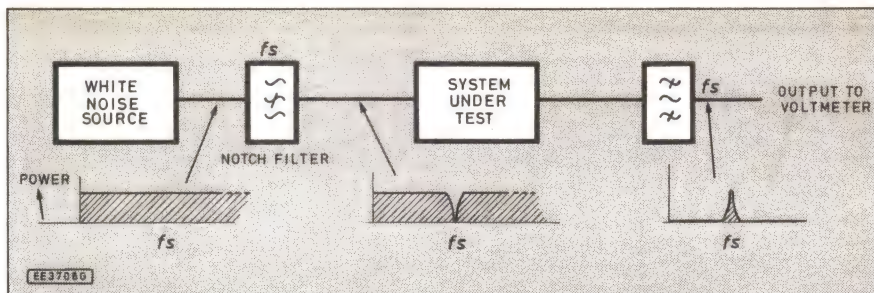


Fig. 5. Intermodulation measurement by "noise in slot" method.

pear. These are selected by a sharp filter tuned to f_s and their amplitude measured to indicate the severity of the distortion.

White noise is not a good simulator of music, which contains more energy at

low frequencies than at high ones. If white noise is passed through a spectrum-shaping filter which applies the right degree of top cut the resulting "pink noise" is more like real audio signals.

EVERYDAY READOUT

CONSIDERABLE RELIEF

Dear Ed.,

When I last wrote to you in January I mentioned that I hoped to be relieved of the secretarial duties of the B.A.E.C. by another member who had volunteered to take these over. At the beginning of this week I visited Jeremy Hind, the member in question, to finalise the arrangement. He already has about three quarters of the membership on his computer database of members' electronic expertise, so the amount of extra work will not be too great, but it will be a considerable relief to me. I shall continue as chairman for the present, and shall continue to edit the newsletter. I should be grateful if you would amend the small advertisement for the B.A.E.C. at the next time of insertion so that the last part reads: "For details, write to the Secretary, Mr. J.S. Hind, 7 Carlyle Road, West Bridgford, Nottingham NG2 7NS."

Some of the other magazines have carried small ads for a club calling itself "Electronics UK", based in Lancing. I wrote as chairman of the B.A.E.C., asking for details, but have had no reply. The National Components Club seems to have folded up - I haven't seen any of their adverts recently.

I am pleased that you have started publishing readers' letters. Your correspondent Mr. Pike wrote to me before writing to you about his diesel tachometer. I get a few letters of this sort from people who think the advert for the B.A.E.C. in your classified section, which says it "exists to help electronics enthusiasts", is a general invitation to all and sundry to send their problems to me. I do help if I can, but I also point out to them that the help is to members of the club (and I send them details and a membership application form - but this rarely has any effect; I don't even get an acknowledgment as a rule).

Your editorial pat on the back was well justified. I always find much of interest in each issue as it reaches me and if I do criticise from time to time, this is meant to be constructive and helpful. The number

of enquiries I get from distant countries is ample evidence of EEs wide circulation, and some of them are not a little odd or amusing. I respond to them all, but in many cases that is the last I hear from the senders. Perhaps they expect to get the club services free of charge.

H.F. Howard
Chairman B.A.E.C.

This is part of a lengthy letter from Herbert we hope to publish more of it next month.

PULSED MOTOR PROBLEMS

Dear Ed.,

Robert Penfold's advocacy of pulsed controllers for model railways in the April issue should perhaps have contained a motor health warning! Pulsed controllers arouse considerable controversy in specialised model-railway publications, with sad stories of smoking armatures and demagnetised magnets said to sometimes follow their use, as well as complaints of excessive hum from some motors at the drive frequency. I believe the present main warning is that they should not be used with "can-motors", and the May issue of *Continental Modeller* reviewing a German-made locomotive quotes the accompanying leaflet as saying that it is powered by a "Faulhaber" motor which must not be used with "pulse power units".

My own experience when devising a controller for use with computer control is that if low-enough frequencies are employed the motors respond like "stepper-motors" advancing a small amount for each pulse. Unfortunately, with a mixed fleet of locomotives, the optimum frequencies vary between about 12 and 30Hz, and I have compromised on 18Hz. Readers might like to experiment with a shunting locomotive - reliable progress seems possible at scale speeds as low as 2mph on clean track. Mindful of pulse control warnings I employ increasing pulse width at 16V up to about 15 per cent mark-space ratio and then further increase speed by raising the "space" voltage so that the

top-speed waveform is 10V d.c. with the 16V 16 per cent pulses superimposed.

This works satisfactorily for me, and I find that charging the capacitor carrying the control voltage from a constant-current source over about 15sec. gives visually acceptable acceleration. For stopping I use a track reed switch to trigger an initial slowing to about 20mph using a C-R discharge of the capacitor to the lower voltage over about 6sec., with a second reed then triggering a discharge to a control-voltage rather below the zero-speed value over about 3sec. These decelerations look reasonably realistic to me, and consistent stopping positions are obtained to within a few cms.

A gimmick I employ with this pulse system is that train-detector circuits are referenced to 13V so that l.e.d.s on the track-diagram show an 18Hz flicker for moving trains and are steady for stationary ones.

T. B. Owen
Aberystwyth

COMPUTER UPSET

Dear Ed.,

Not long after moving house just recently I began to experience intermittent malfunctions with my home computer. These machine errors happened two or three times a day, I put it down to mechanical damage whilst moving.

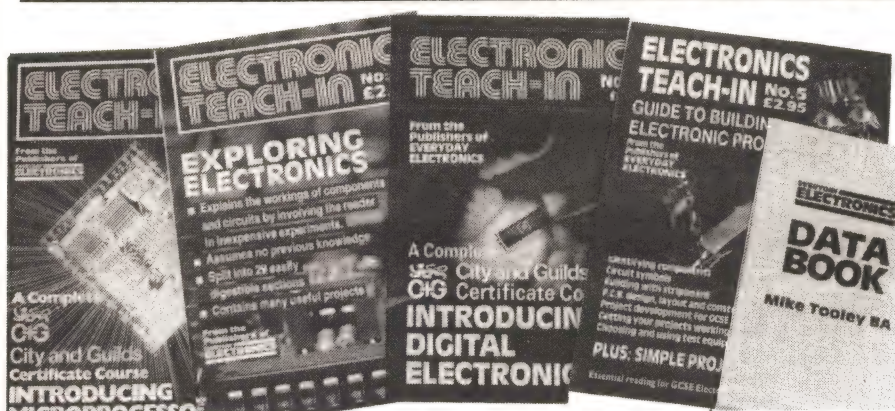
I myself, not having much knowledge of computer electronics called for the services of a professional Computer Engineer, after explaining the symptoms he gave the PC a thorough check, he then informed me no fault could be found but suggested that as the problem was intermittent and the PC was somewhat old, it could be susceptible to noise not conducted but radiated at some external source, Radio Frequency Interference (R.F.I.). This sometimes occurs in certain environments and when asked how this could be rectified he said it was not viable to work on a computer of that age and to invest in a new one.

Do older machines suffer from R.F.I.? Have you or any other readers experienced problems caused by R.F.I. in computer or microprocessor controlled equipment? What are the potential sources of R.F.I. and how do you overcome them? Are there any good books on the subject, I have searched several good bookshops but to no avail 'Please help'.

J. Connors
Cambridge

It sounds more like r.f.i. or spikes on the mains, often caused by inductive loads switching on an off, rather than a radiated r.f.i. problem. We would suggest you try a mains filter before getting involved with trying to eliminate radiated r.f.i. Perhaps other readers will have had similar experiences?

SPECIAL EVERYDAY ELECTRONICS BOOKS



ELECTRONICS TEACH-IN 88/89-INTRODUCING MICROPROCESSORS

Mike Tooley BA (published by *Everyday Electronics*)
A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc.

Sections cover Microcomputer Systems, Micro-processors, Memories, Input/Output, Interfacing and Programming. There are various practical assignments and eight Data Pages covering the most popular microprocessor chips.

An excellent introduction to the subject even for those who do not wish to take the City and Guilds assessment.
80 pages (A4 size) **Order code TI 88 89** **£2.45**

ELECTRONIC PROJECTS BOOK 1

Published by *Everyday Electronics* in association with *Magenta Electronics*.

Contains twenty of the best projects from previous issues of *EE* each backed with a kit of components. The projects are: Seashell Sea Synthesiser, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three Channel Sound to Light, BBC 16K sideways Ram, Simple Short Wave Radio, Insulation Tester, Stepper Motor interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm EE Equaliser

Ioniser, Bat Detector, Acoustic Probe, Mainstester and Fuse Finder, Light Rider - (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.
128 pages (A4 size) **Order code EP1** **£2.45**

ELECTRONICS TEACH-IN No. 3 - EXPLORING ELECTRONICS (published by *Everyday Electronics*)

Owen Bishop
Another *EE* value for money publication aimed at students of electronics. The course is designed to explain the workings of electronic components and circuits by involving the reader in experimenting with them. The book does not contain masses of theory or formulae but straightforward explanations and circuits to build and experiment with.

Exploring Electronics contains more than 25 useful projects, assumes no previous knowledge of electronics and is split into 28 easily digestible sections.
88 pages (A4 size) **Order code TI3** **£2.45**

ELECTRONICS TEACH-IN No. 4 INTRODUCING DIGITAL ELECTRONICS (published by *Everyday Electronics*)

Michael J. Cockcroft
Although this book is primarily a City & Guilds Introductory level course (726/301), approximately 80% of the informa-

tion forms a very basic introduction to electronics in general, it therefore provides an excellent introductory text for beginners and a course and reference book for GCSE students.

Full details on registering for C&G assessment, details of assessment centres, components required and information on the course in general are given.

The City & Guilds introduction to module 726/301 reads: "A candidate who satisfactorily completes this module will have a competence to identify basic components and digital integrated circuits and connect them together to form simple working circuits and logic units." This provides an excellent introduction to the book.

112 pages (A4 size) **Order code TI4** **£2.95**

ELECTRONICS TEACH-IN No. 5 GUIDE TO BUILDING ELECTRONIC PROJECTS

Published by *EVERYDAY ELECTRONICS*
Due to the demand from students, teachers and hobbyists we have put together a range of articles from past issues of *Everyday Electronics* that will assist those involved with the construction of electronic projects.

The book contains the complete *Project Development for GCSEs*.

Contents: Features - First Steps in Project Building; Building with Vero; Project Development for GCSE; Getting your Projects Working; Guide to Printed Circuit Boards; Choosing and Using Test Equipment - The Multimeter, The Oscilloscope, P.S.U.s, Logic Probes, Digital Frequency Meters, Signal Generators, etc; **Data** - Circuit Symbols; Component Codes; Resistors; Identifying Components; Capacitors; Actually Doing It - Understanding the Circuit Diagram, Component Codes, Mounting circuit boards and controls, Understanding Capacitors; **Projects** - Lie Detector; Personal Stereo Amplifier; Digital Experimenters' Unit; Quizmaster; Siren Effects Unit; UV Exposure Unit; Low-cost Capacitance Meter; Personal Radio.
88 pages (A4 size) **Order code TI5** **£2.95**

EVERDAY ELECTRONICS DATA BOOK

Mike Tooley BA
(published by *EE* in association with *PC Publishing*)

This book is an invaluable source of information of everyday relevance in the world of electronics. It contains not only sections which deal with the essential theory of electronic circuits, but it also deals with a wide range of practical electronic applications.

It is ideal for the hobbyist, student, technician and engineer. The information is presented in the form of a basic electronic recipe book with numerous examples showing how theory can be put into practice using a range of commonly available "industry standard" components and devices.

A must for everyone involved in electronics!
256 pages **Order code DATA** **£8.95**

DIRECT BOOK SERVICE

The books listed have been selected by *Everyday Electronics* editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page. For another selection of books see next month's issue

ELECTRONIC TEST EQUIPMENT HANDBOOK

Steve Money

The principles of operation of the various types of test instrument are explained in simple terms with a minimum of mathematical analysis. The book covers analogue and digital meters, bridges, oscilloscopes, signal generators, counters, timers and frequency measurement. The practical uses of the instruments are also examined.

Everything from Audio oscillators, through R, C & L measurements (and a whole lot more) to Waveform Generators and testing Zeners. A truly comprehensive book for the hobbyist, student, technician and engineer.
206 pages **Order code PC109** **£8.95**

HOW TO TEST ALMOST EVERYTHING

ELECTRONIC - 2nd EDITION

Jack Darr and Delton T. Horn

Describes electronic tests and measurements - how to make them with all kinds of test equipment, and how to interpret the results. New sections in this edition include logic probes, frequency counters, capacitance meters, and more. (An American book.)
190 pages **Order code T2925** **£9.05**

GETTING THE MOST FROM YOUR MULTIMETER

R. A. Penfold

This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.

In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.
96 pages **Order code BP239** **£2.95**

MORE ADVANCED USES OF THE MULTIMETER

R. A. Penfold

This book is primarily intended as a follow-up to BP239, (see above), and should also be of value to anyone who already understands the basics of voltage testing and simple component testing. By using the techniques described in chapter 1 you can test and analyse the performance of a range of components with just a multimeter

TESTING, THEORY AND REFERENCE

(plus a very few inexpensive components in some cases). Some useful quick check methods are also covered.

While a multimeter is supremely versatile, it does have its limitations. The simple add-ons described in chapter 2 extended the capabilities of a multimeter to make it even more useful. The add-ons described include an active r.f. probe, a high resistance probe, an a.c. sensitivity booster, and a current tracer unit.
84 pages **Order code BP265** **£2.95**

THE ILLUSTRATED DICTIONARY OF ELECTRONICS - 4th EDITION

Rufus P. Turner and Stan Gibilisco

With more than 27,000 terms used in electronics today, this collection is THE most comprehensive dictionary available. Including all practical electronics and computer terms, it is as up-to-date as the latest advances in the field itself! Tables and data on subjects most often consulted for projects and experiments are included. Other conversion tables include English/metric and metric/English conversions for units of energy, power and volume, and Fahrenheit/Celsius temperature conversion charts.

Setting this edition apart from other electronic dictionaries is its emphasis on illustration. Featuring more than complete definitions, this fourth edition includes over 450 detailed drawings and diagrams.

All entries are listed in alphabetical order. Abbreviations and initials are listed in sequence with whole words. All terms of more than one word are treated as one word. (An American book.)
648 pages **Order code T2900** **£23.95**

ELECTRONICS - A "MADE SIMPLE" BOOK

G. H. Olsen

This book provides excellent background reading for our *Introducing Digital Electronics* series and will be of interest to everyone studying electronics. The subject is simply explained and well illustrated and the book assumes only a very basic knowledge of electricity.
330 pages **Order code NE10** **£4.95**

PRACTICAL ELECTRONICS CALCULATIONS AND FORMULAE

F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Bridges the gap between complicated technical theory, and "cut-and-try" methods which may bring success in design but leave the experimenter unfulfilled. A strong

practical bias - tedious and higher mathematics have been avoided where possible and many tables have been included.

The book is divided into six basic sections: Units and Constants, Direct-current Circuits, Passive Components, Alternating-current Circuits, Networks and Theorems, Measurements.
256 pages **Order code BP53** **£3.95**

PRACTICAL DIGITAL ELECTRONICS HANDBOOK

Mike Tooley (Published in association with *Everyday Electronics*)

The vast majority of modern electronic systems rely heavily on the application of digital electronics, and the *Practical Digital Electronics Handbook* aims to provide readers with a practically based introduction to this subject. The book will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry, as well as to those wishing to update their knowledge of modern digital devices and techniques. Contents: Introduction to integrated circuits; basic logic gates; monostable and bistable devices; timers; microprocessors; memories; input and output devices; interfaces; microprocessor buses. Appendix 1: Data. Appendix 2: Digital test gear projects; tools and test equipment; regulated bench power supply; logic probe; logic pulser; versatile pulse generator; digital IC tester; current tracer; audio logic tracer; RS-232C breakout box; versatile digital counter/frequency meter. Appendix 3: The oscilloscope. Appendix 4: Suggested reading. Appendix 5: Further study.
208 pages **Order code PC100** **£6.95**

ELECTRONICS-BUILD AND LEARN

R. A. Penfold

The first chapter gives full constructional details of a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components - resistors, capacitors, transformers, diodes, transistors, thyristors, fets and op amps. Later chapters go on to describe how these components are built up into useful circuits, oscillators, multivibrators, bistables and logic circuits.

At every stage in the book there are practical tests and experiments that you can carry out on the demonstrator unit to investigate the points described and to help you understand the principles involved. You will soon be able to go on to more complex circuits and tackle fault finding logically in other circuits you build.
120 pages **Order code PC103** **£5.95**

AUDIO AND MUSIC

LOUDSPEAKERS FOR MUSICIANS

NEW

Vivian Capel

This book contains all that a working musician needs to know about loudspeakers; the different types, how they work, the most suitable for different instruments, for cabaret work, and for vocals. It gives tips on constructing cabinets, wiring up, when and where to use wadding, and when not to, what fittings are available, finishing, how to ensure they travel well, how to connect multi-speaker arrays and much more.

Ten practical enclosure designs with plans and comments are given in the last chapter, but by the time you've read that far you should be able to design your own! 164 pages Order code BP297 £3.95

MAKE MONEY FROM HOME RECORDING

Clive Brooks

Now that you've spent a fortune on all that recording gear, MIDI and all, wouldn't it be nice to get some of it back? Well here's the book to show you how.

It's packed with money making ideas, any one of which will recoup the price of the book many times over. Whether you have a fully fledged recording studio at home, or just a couple of stereo cassette recorders and a microphone, you'll be able to put the ideas in this book into practice and make money. 105 pages Order code PC104 £5.95

INTRODUCTION TO DIGITAL AUDIO

(Second Edition)

Ian Sinclair

Digital recording methods have existed for many years and have become familiar to the professional recording engineer, but the compact disc (CD) was the first device to bring digital audio methods into the home. The next step is the appearance of digital audio tape (DAT) equipment.

All this development has involved methods and circuits that are totally alien to the technician or keen amateur who has previously worked with audio circuits. The principles and practices of digital audio owe little or nothing to the traditional linear circuits of the past, and are much more comprehensible to today's computer engineer than the older generation of audio engineers.

This book is intended to bridge the gap of understanding for the technician and enthusiast. The principles and methods are explained, but the mathematical background and theory is avoided, other than to state the end product. 128 pages Order code PC102 £6.95

SYNTHESIZERS FOR MUSICIANS

R. A. Penfold

Modern synthesizers are extremely complex, but they mostly work on principles that are not too difficult to

understand. If you want to go beyond using the factory presets or the random poking of buttons, this is the book for you.

It covers the principles of modern synthesis – linear arithmetic as used by Roland, phase distortion (Casio), Yamaha's frequency modulation, and sampling – and then describes how the instruments are adjusted to produce various types of sound – strings, brass, percussion, etc. The theoretical side of synthesis is treated in an easy to understand way – the technical information being restricted to what you need to know to use your instrument effectively. 168 pages Order code PC105 £6.95

AUDIO

F. A. Wilson, C. G. I. A., C. Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.

Analysis of the sound wave and an explanation of acoustical quantities prepare the way. These are followed by a study of the mechanism of hearing and examination of the various sounds we hear. A look at room acoustics with a subsequent chapter on microphones and loudspeakers then sets the scene for the main chapter on audio systems – amplifiers, oscillators, disc and magnetic recording and electronic music. 320 pages Order code BP111 £3.95

CIRCUITS AND DESIGN

REMOTE CONTROL HANDBOOK

Owen Bishop

Remote control systems lend themselves to a modular approach. This makes it possible for a wide range of systems, from the simplest to the most complex, to be built up from a number of relatively simple modules. The author has tried to ensure that, as far as possible, the circuit modules in this book are compatible with one another. They can be linked together in many different configurations to produce remote control systems tailored to switch a table lamp on and off, or to operate an industrial robot, this book should provide the circuit you require. 226 pages Order code BP240 £3.95

COIL DESIGN AND CONSTRUCTION MANUAL

B. B. Babani

A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and transformers. Practically every possible type is discussed and calculations necessary are given and explained in detail. Although this book is now rather old, with the exception of toroids and pulse transformers little has changed in coil design since it was written. 96 pages Order code T60 £2.50

30 SOLDERLESS BREADBOARD PROJECTS – BOOK 1

R. A. Penfold

Each project, which is designed to be built on a "Verobloc" breadboard, is presented in a similar fashion with a brief circuit description, circuit diagram, component layout diagram, components list and notes on construction and use where necessary. Whenever possible, the components used are common to several projects, hence with only a modest number of reasonably inexpensive components, it is possible to build in turn, every project shown. Recommended by BICC-Verobloc. 160 pages Order code BP107 £2.95

BOOK 2 –

All projects use CMOS i.c.s. but the items on component identification etc., are not repeated from Book 1. 160 pages Order code BP113 £2.25

ELECTRONIC CIRCUITS HANDBOOK

Michael Tooley BA

This book aims to explode two popular misconceptions concerning the design of electronic circuits: that only those with many years of experience should undertake circuit design and that the process relies on an understanding of advanced mathematics. Provided one is not too ambitious, neither of these popularly held beliefs is true.

Specifically, this book aims to provide the reader with a unique collection of practical working circuits together with supporting information so that circuits can be produced in the shortest possible time and without recourse to theoretical texts.

Furthermore, information has been included so that the circuits can readily be modified and extended by readers to meet their own individual needs. Related circuits have been grouped together and cross-referenced within the text (and also in the index) so that readers are aware of which circuits can be readily connected together to form more complex systems. As far as possible, a common range of supply voltages, signal levels and impedances has been adopted.

As a bonus, ten test gear projects have been included. These not only serve to illustrate the techniques described but also provide a range of test equipment which is useful in its own right. 277 pages Temporarily out of print

AUDIO IC CIRCUITS MANUAL

R. M. Marston

A vast range of audio and audio-associated i.c.s. are readily available for use by amateur and professional design engineers and technicians. This manual is a guide to the most popular and useful of these devices, with over 240 diagrams. It deals with i.c.s. such as low frequency linear amplifiers, dual pre-amplifiers, audio power amplifiers, charge coupled device delay lines, bar-graph display drivers, and power supply regulators, and shows how to use these devices in circuits ranging



from simple signal conditioners and filters to complex graphic equalizers, stereo amplifier systems, and echo/reverb delay line systems etc. 168 pages Order code NE13 £12.95

HOW TO DESIGN ELECTRONIC PROJECTS

R. A. Penfold

The aim of this book is to help the reader to put together projects from standard circuit blocks with a minimum of trial and error, but without resorting to any advanced mathematics. Hints on designing circuit blocks to meet your special requirements are also provided. 128 pages Temporarily out of print

50 CIRCUITS USING GERMANIUM SILICON AND ZENER DIODES

R. N. Soar

Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most simple and inexpensive of components – the diode. Includes the use of germanium and silicon signal diodes, silicon rectifier diodes and Zener diodes, etc. 64 pages Order code BP36 £1.95

DESIGNING WITH LINEAR ICs

G. C. Loveday

A book that deals with the design of the vital area of analog circuitry covering design with modern linear integrated circuit devices. The first chapter introduces the reader to important design techniques, test strategies, layout, and protection and also includes a section on the use of a typical CAD tool. There are separate chapters that cover in depth the use of op-amps, comparators and timers each with detailed design examples and reader exercises. A final chapter brings all the previous work together in a number of complete design problems with fully worked solutions. The text is essentially non-mathematical and is supported by many diagrams. 64 pages Order code BM3 Special Price £5.00

TIMER/GENERATOR CIRCUITS MANUAL

R. M. Marston

This manual is concerned mainly with waveform generator techniques and circuits. Waveform generators are used somewhere or other in most types of electronic equipment, and thus form one of the most widely used classes of circuit. They may be designed to produce outputs with sine, square, triangle, ramp, pulse, staircase, or a variety of other forms. The generators may produce modulated or unmodulated outputs, and the outputs may be of single or multiple form.

Waveform generator circuits may be built using transistors, op-amps, standard digital ICs, or dedicated waveform or "function" generator ICs.

The manual is divided into eleven chapters, and presents over 300 practical circuits, diagrams and tables. The subjects covered include: Basic principles; Sine wave generators; Square wave generators; Pulse generator circuits; "Timer IC" generator circuits; Triangle and sawtooth generators; Multi-waveform generation; Waveform synthesizer ICs; Special waveform generators; Phaselocked loop circuits; Miscellaneous "555" circuits. 267 pages Order code NE18 £12.95

OPTOELECTRONICS CIRCUITS MANUAL

R. M. Marston

A useful single-volume guide to the optoelectronics device user, specifically aimed at the practical design engineer, technician, and the experimenter, as well as the electronics student and amateur. It deals with the subject in an easy-to-read, down-to-earth, and non-mathematical yet comprehensive manner, explaining the basic principles and characteristics of the best known devices, and presenting the reader with many practical applications and over 200 circuits. Most of the i.c.s. and other devices used are inexpensive and readily available types, with universally recognised type numbers. 182 pages Order code NE14 £12.95

POPULAR ELECTRONIC CIRCUITS – BOOK 1

POPULAR ELECTRONIC CIRCUITS – BOOK 2

R. A. Penfold

Each book provides a wide range of designs for electronic enthusiasts who are capable of producing working projects from just a circuit diagram without the aid of detailed construction information. Any special setting-up procedures are described.

BOOK 1 160 pages Order code BP80 £2.95

BOOK 2 160 pages Order code BP98 £2.95

CMOS CIRCUITS MANUAL

R. M. Marston

Written for the professional engineer, student or enthusiast. It describes the basic principles and characteristics of these devices and includes over 200 circuits.

All the circuits have been designed, built and fully evaluated by the author; all use inexpensive and internationally available devices. 187 pages Order code NE12 £12.95

Note – our postage charge is the same for one book or one hundred books!

OPTOELECTRONICS CIRCUITS MANUAL

Popular Electronic Circuits Book 2



PROJECT CONSTRUCTION

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s

R. A. Penfold

Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.
80 pages

Order code BP121 £2.50

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING

R. A. Penfold

We have all built projects only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.
96 pages

Order code BP110 £2.50

ELECTRONIC SCIENCE PROJECTS

O. Bishop

These projects range in complexity from a simple colour temperature meter to an infra-red laser. There are novelties such as an electronic clock regulated by a resonating spring, and an oscilloscope with solid-state display. There are scientific measuring instruments such as a pH meter and an electro-cardiometer. All projects have a strong scientific flavour. The way they work, and how to build and use them are fully explained.
144 pages

Temporarily out of print

BEGINNER'S GUIDE TO BUILDING ELECTRONICS PROJECTS

R. A. Penfold

Shows the complete beginner how to tackle the practical side of electronics, so that he or she can confidently build the electronic projects that are regularly featured in

magazines and books. Also includes examples in the form of simple projects.
112 pages

Order code 227 £1.95

TEST EQUIPMENT CONSTRUCTION

R. A. Penfold

This book describes in detail how to construct some simple and inexpensive but extremely useful, pieces of test equipment. Stripboard layouts are provided for all designs, together with wiring diagrams where appropriate, plus notes on construction and use.

The following designs are included:- AF Generator, Capacitance Meter, Test Bench Amplifier, AF Frequency Meter, Audio Millivoltmeter, Analogue Probe, High Resistance Voltmeter, CMOS Probe, Transistor Tester, TTL Probe. The designs are suitable for both newcomers and more experienced hobbyists.
104 pages

Order code BP248 £2.95

DATA AND COMPONENT IDENTIFICATION

CHART OF RADIO, ELECTRONIC, SEMICONDUCTOR AND LOGIC SYMBOLS

M. H. Banani B.Sc. (Eng.)

Illustrates the common, and many of the not-so-common, radio, electronic, semiconductor and logic symbols that are used in books, magazines and instruction manuals, etc., in most countries throughout the world.
Chart

Order code BP27 £0.95

INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE

A. Michaels

Helps the reader to find possible substitutes for a popular selection of European, American and Japanese transistors. Also shows material type, polarity, manufacturer and use.
320 pages

Order code BP85 £3.95

RADIO, TV, SATELLITE

SETTING UP AN AMATEUR RADIO STATION

I. D. Poole

The aim of this book is to give guidance on the decisions which have to be made when setting up any amateur radio or short wave listening station. Often the experience which is needed is learned by one's mistakes, however, this can be expensive. To help overcome this, guidance is given on many aspects of setting up and running an efficient station. It then proceeds to the steps that need to be taken in gaining a full transmitting licence.

Topics covered include: The equipment that is needed; Setting up the shack; Which aerials to use; Methods of construction; Preparing for the licence.

An essential addition to the library of all those taking their first steps in amateur radio
86 pages

Order code BP300 £3.95

BEGINNER'S GUIDE TO RADIO - 9th EDITION

Gordon J. King

Radio signals, transmitters, receivers, antennas, components, valves and semiconductors, CB and amateur radio.
266 pages

Order code NE08 £6.95

AN INTRODUCTION TO RADIO DXING

R. A. Penfold

Anyone can switch on a short wave receiver and play with the controls until they pick up something, but to find a particular station, country or type of broadcast and to receive it as clearly as possible requires a little more skill and knowledge. The object of this book is to help the reader to do just that, which in essence is the fascinating hobby of radio DXing.
112 pages

Order code BP91 £1.95

EXPERIMENTAL ANTENNA TOPICS

H. C. Wright

Although nearly a century has passed since Marconi's first demonstration of radio communication, there is still research and experiment to be carried out in the field of antenna design and behaviour.

The aim of the experimenter will be to make a measurement or confirm a principle, and this can be done with relatively fragile, short-life apparatus. Because of this, devices described in this book make liberal use of cardboard, cooking foil, plastic bottles, cat food tins, etc. These materials are, in general, cheap to obtain and easily

worked with simple tools, encouraging the trial-and-error philosophy which leads to innovation and discovery.

Although primarily a practical book with text closely supported by diagrams, some formulae which can be used by straightforward substitution and some simple graphs have also been included.
72 pages

Order code BP278 £3.50

NEWNES SHORTWAVE LISTENING HANDBOOK

Joe Pritchard G1UQW

Part One covers the "science" side of the subject, going from a few simple electrical "first principles", through a brief treatment of radio transmission methods to simple receivers. The emphasis is on practical receiver designs and how to build and modify them, with several circuits in the book.

Part Two covers the use of sets, what can be heard, the various bands, propagation, identification of stations, sources of information, QSLing of stations and listening to amateurs. Some computer techniques, such as computer Morse decoding and radio teletype decoding are also covered.
224 pages

Order code NE16 £14.95

COMPUTING

SERVICING PERSONAL COMPUTERS - 2nd EDITION

Mike Tooley BA

The revised and enlarged second edition contains a new chapter on the IBM PC, AT, TX and compatibles. It is essential for anyone concerned with the maintenance of personal computer equipment or peripherals, whether professional service technician, student or enthusiast.
240 pages (Hard cover)

Order code NE15 £25

HOW TO EXPAND, MODERNISE AND REPAIR PCs AND COMPATIBLES

R. A. Penfold

Not only are PC and compatible computers very expandable, but before long most users actually wish to take advantage of that expandability and start upgrading their PC systems. Some aspects of PC upgrading can be a bit confusing, but this book provides advice and guidance on the popular forms of internal PC expansion, and should help to make things reasonably straightforward and painless. Little knowledge of computing is assumed. The only assumption is that you can operate a standard PC of some kind (PC, PC XT, PC AT, or a 80386 based PC).

The subjects covered include: PC overview; Memory upgrades; Adding a hard disk drive; Adding a floppy disk drive; Display adaptors and monitors; Fitting a maths co-processor; Keyboards; Ports; Mice and digitisers; Maintenance (including preventative maintenance) and Repairs, and the increasingly popular subject of d.i.y. PCs.
156 pages

Order code BP271 £4.95

AN INTRODUCTION TO PROGRAMMING THE BBC MODEL B MICRO

R. A. & J. W. Penfold

Written for readers wanting to learn more about programming and how to make best use of the incredibly powerful model B's versatile features. Most aspects of the BBC Micro are covered, the omissions being where little could usefully be added to the information provided by the manufacturer's own manual.
144 pages

Order code BP139 £1.95

AN INTRODUCTION TO 6502 MACHINE CODE

R. A. & J. W. Penfold

No previous knowledge of microprocessors or

machine code is assumed. Topics covered are: assembly language and assemblers, the register set and memory, binary and hexadecimal numbering systems, addressing modes and the instruction set, and also mixing machine code with BASIC. Some simple programming examples are given for 6502-based home computers like the VIC-20, ORIC-1/Atmos, Electron, BBC and also the Commodore 64.
112 pages

Order code BP147 £2.95

The PRE-BASIC BOOK

F. A. Wilson, C.G.I.A., C.ENG., F.I.E.E.,

F.I.E.R.E., F.B.I.M.

Another book on BASIC but with a difference. This one does not skip through the whole of the subject and thereby leave many would-be programmers floundering but instead concentrates on introducing the technique by looking in depth at the most frequently used and more easily understood computer instructions. For all new and potential micro users.
192 pages

Order code BP146 £2.95

DIRECT BOOK SERVICE ORDERING DETAILS

Please state the title and order code clearly, print your name and address and add the required postage to the total order.

Add 75p to your total order for postage and packing (overseas readers add £1.50 for countries in Europe, or add £2.50 for all countries outside Europe, surface mail postage) and send a PO, cheque, international money order (£ sterling only) made payable to Direct Book Service or credit card details (including card expiry date), Visa or Mastercard (Access) - minimum credit card order is £5 - quoting your name and address, the order code and quantities required to DI-

RECT BOOK SERVICE, 33 GRAVEL HILL, WIMBORNE, DORSET BH21 1RW (mail order only).

Although books are normally sent within seven days of receipt of your order, please allow a maximum of 28 days for delivery. Overseas readers allow extra time for surface mail post.

Please check price and availability (see latest issue of *Everyday Electronics*) before ordering from old lists.

Note - our postage charge is the same for one book or one hundred books!

MORE BOOKS NEXT MONTH

DIRECT BOOK SERVICE IS A DIVISION OF WIMBORNE PUBLISHING LTD.

BABANI BOOKS

We now supply *all* the books published by Bernard Babani (Publishing) Ltd. We have always supplied a selected list of Babani books and you will find many of them described on the previous pages or in next months issue of *Everyday Electronics* (the books with a BP prefix to the order code are Babani books).

Many readers have asked us to also supply various other Babani books, which have a reputation for value for money. Our customers tell us they appreciate our speedy service and low postage charge and they

would like to be able to purchase all the books from us and thus keep the postage charge to an absolute minimum (**75p for UK p&p no matter how many books you buy**). We are pleased to be able to respond; with the aid of Michael Babani (M.D.) we are now able to meet all your requirements for their books. *If it's Babani and in print we can supply it.* Babani presently list over 180 different technical titles those *not* described in detail on the previous *Direct Book Service* pages or in next months issue are listed below:

Code	Title	Price	Code	Title	Price	Code	Title	Price
208	Practical Stereo & Quadraphony Handbook	£0.75	BP138	BASIC & FORTH in Parallel	£1.95	BP245	Digital Audio Projects	£2.95
214	Audio Enthusiast's Handbook	£0.85	BP143	An Introduction to Programming the Atari 600/800XL	£1.95	BP246	Musical Applications of the Atari ST's	£5.95
219	Solid State Novelty Projects	£0.85	BP144	Further Practical Electronics Calculations & Formulae	O.O.P.	BP247	More Advanced MIDI Projects	£2.95
225	A Practical Introduction to Digital ICs	O.O.P.	BP145	25 Simple Tropical and MW Band Aerials	£1.95	BP249	More Advanced Test Equipment Construction	£4.95
BP28	Resistor Selection Handbook	£0.60	BP148	Computer Terminology Explained	£1.95	BP250	Programming in FORTRAN 77	£4.95
BP37	50 Projects using Relays, SCRs and TRIACs	£2.95	BP149	A Concise Introduction to the Language of BBC Basic	£1.95	BP251	Computer Hobbyists Handbook	£5.95
BP39	50 (FET) Field Effect Transistor Projects	£2.95	BP153	An Introduction to Programming the Amstrad CPC 464 & 664	£2.50	BP258	Learning to Program in C	£4.95
BP44	IC 555 Projects	£2.95	BP154	An Introduction to MSX BASIC	£2.50	BP259	A Concise Introduction to UNIX	£2.95
BP45	Projects in Opto-Electronics	O.O.P.	BP156	An Introduction to QL Machine Code	£2.50	BP260	A Concise Introduction to OS/2	£2.95
BP48	Electronic Projects for Beginners	£1.95	BP157	How to Write ZX Spectrum & Spectrum + Games Programs	£2.50	BP261	A Concise Introduction to Lotus 1-2-3 (Revised Edition)	£3.95
BP49	Popular Electronic Projects	£2.50	BP158	An Introduction to Programming the Commodore 16 & Plus 4	£2.50	BP262	A Concise Introduction to Wordperfect (Revised Edition)	£3.95
BP56	Electronic Security Devices	£2.50	BP159	How to Write Amstrad CPC464 Games Programs	£2.50	BP263	A Concise Introduction to dBASE	£3.95
BP58	50 Circuits Using 7400 Series IC's	£2.50	BP161	Counting on QL Abacus	£2.50	BP264	A Concise Advanced User's Guide to MS-DOS	£2.95
BP62	The Simple Electronic Circuits & Components (Elements of Electronics - Book 1)	£3.50	BP162	Easy Add-on Projects for Amstrad CPC 464, 664, 6128 and MSX Computers	£2.95	BP270	A Concise Introduction to Symphony	£3.95
BP63	Alternating Current Theory (Elements of Electronics - Book 2)	£3.50	BP171	More Advanced Electronic Music Projects	£2.95	BP272	Interfacing PC's & Compatibles	£4.95
BP64	Semiconductor Technology (Elements of Electronics - Book 3)	£3.50	BP175	How to Write Word Game Programs for the Amstrad CPC 464, 664 and 6128	£2.95	BP273	Practical Electronic Sensors	£4.95
BP68	Choosing and Using Your Hi-Fi	£1.65	BP182	MIDI Projects	£2.95	BP274	A Concise Introduction to SuperCal5	£3.95
BP69	Electronic Games	£1.75	BP183	An Introduction to CPM	£2.95	BP276	Short Wave Superhet Receiver Construction	£2.95
BP74	Electronic Music Projects	£2.50	BP187	A Practical Reference Guide to Word Processing on the Amstrad PCW8256 and PCW8512	£5.95	BP277	High Power Audio Amplifier Construction	£3.95
BP76	Power Supply Projects	£2.50	BP189	Using Your Amstrad CPC Disc Drives	£2.95	BP279	A Concise Introduction to Excel	£3.95
BP78	Practical Computer Experiments	£1.75	BP190	More Advanced Electronic Security Projects	£2.95	BP280	Getting the Most From Your PC's Hard Disc	£3.95
BP84	Digital IC Projects	£1.95	BP191	Simple Application of the Amstrad CPC's for Writers	£2.95	BP283	A Concise Introduction to SmartWare II	£4.95
BP86	An Introduction to BASIC Programming Techniques	£1.95	BP192	More Advanced Power Supply Projects	£2.95	BP284	Programming in QuickBASIC	£4.95
BP90	Audio Projects	£2.50	BP193	LOGO for Beginners	£2.95	BP286	A Reference Guide to Basic Electronics Terms	£5.95
BP94	Electronic Projects for Cars and Boats	£1.95	BP196	BASIC & LOGO in Parallel	£5.95	BP288	A Concise Introduction to Windows 3.0	£3.95
BP95	Model Railway Projects	£2.95	BP197	An Introduction to the Amstrad PC's	£2.95	BP291	A Concise Introduction to Ventura	£3.95
BP97	IC Projects for Beginners	£1.95	BP198	An Introduction to Antenna Theory	£2.95	BP292	Public Address Loudspeaker Systems	£3.95
BP99	Mini-matrix Board Projects	£2.50	BP199	An Introduction to BASIC 2 on the Amstrad PC's	£2.95	BP293	An Introduction to Radio Wave Propagation	£3.95
BP106	Modern Op-amp Projects	£1.95	BP230	A Concise Introduction to GEM	£2.95	BP294	A Concise Introduction to Microsoft Works	£4.95
BP109	The Art of Programming the 1K ZX81	£1.95	BP243	BBC BASIC86 on the Amstrad PC's and IBM Compatibles - Book 1: Language	£3.95	BP298	A Concise Introduction to the Mac System & Finder	£3.95
BP114	The Art of Programming the 16K ZX81	£2.50	BP244	BBC BASIC86 on the Amstrad PC's and IBM Compatibles - Book 2: Graphics and Disk Files	£3.95	BP299	Practical Electronic Filters	£4.95
BP120	Audio Amplifier Fault-finding Chart	£0.95				BP302	A Concise Users Guide to Lotus 1-2-3 Release 3.1	£3.95
BP122	Audio Amplifier Construction	£2.95				BP303	Understanding PC Software	£4.95
BP125	25 Simple Amateur Band Aerials	£1.95				BP304	Projects for Radio Amateurs and S.W.L.s	£3.95
BP126	BASIC & PASCAL in Parallel	£1.50				BP307	A Concise Introduction to QuarkXPress	£4.95
BP128	20 Programs for the ZX Spectrum & 16K ZX81	£1.95				BP309	Preamplifier and Filter Circuits	£3.95
BP129	An Introduction to Programming the ORIC-1	£1.95				BP312	An Introduction to Microwaves	£3.95
BP132	25 Simple SW Broadcast Band Aerials	£1.95				BP313	A Concise Introduction to Sage	£3.95
BP133	An Introduction to Programming the Dragon 32	£1.95				BP314	A Concise Introduction to Quattro Pro	£4.95
BP136	25 Simple Indoor and Window Aerials	£1.75				BP318	A Concise User's Guide to MS-DOS 5	£4.95
BP137	BASIC & FORTH in Parallel	£1.95						

IF NO PRICE IS SHOWN THE BOOK IS OUT OF PRINT (O.O.P.)
SEE PREVIOUS PAGE FOR FULL ORDERING DETAILS

PCB SERVICE

Printed circuit boards for certain EE constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for airmail outside of Europe. Remittances should be sent to **The PCB Service, *Everyday Electronics*, 6 Church Street, Wimborne, Dorset BH21 1JH.** Cheques should be crossed and made payable to *Everyday Electronics* (Payment in £ sterling only).

NOTE: While 95% of our boards are now held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery - overseas readers allow extra if ordered by surface mail.

Please check price and availability in the latest issue.

Boards can only be supplied on a payment with order basis.

SALE! All p.c.b.s on this page reduced to **1/2 PRICE**

(Just send half the price shown, while stocks last.)
PCBS ON OPPOSITE PAGE PRICES AS SHOWN

PROJECT TITLE	Order Code	Cost
Video Guard Alarm	FEB '87	556 £3.80
Computer Buffer/Interface	MAR '87	560 £3.32
Fridge Alarm	MAY '87	565 £3.00
Mini Disco Light	JUNE '87	567 £3.00
Fernostat	JULY '87	569 £3.34
Monomixer		571 £4.75
Noise Gate	SEP '87	577 £4.41
BBC Sideways RAM/ROM	NOV '87	585 £4.10
Pseudo Echo Unit	DEC '87	586 £4.60
Game Timer	FEB '88	583 £3.55
SOS Alert	MAR '88	595 £3.00
Pipe & Cable Locator	APR '88	598 £3.00

PROJECT TITLE	Order Code	Cost
Door Sentinel	MAY '88	605 £3.00
Multi-Chan Remote Light Dim Relay/Decoder	JUNE '88	601 £4.86
Power Supply		603 £3.00
Video Wiper	JULY '88	612 £6.75
Tea Tune Thermostat	AUG '88	609 £3.00
Time Switch		614 £4.84
Suntan Timer		610 £3.07
Car Alarm		615 £3.12
Eprom Eraser	OCT '88	620 £4.07
Doorbell Delay	NOV '88	616 £3.56
Infra-Red Object Counter (Set)		622/3/4 £9.28
Downbeat Metronome	DEC '88	629 £4.84
EPROM Programmer (On Spec)		630 £8.29
Phasor		631 £5.64
Continuity Tester	FEB '89	619 £2.67
Mini PSU		636 £3.23
Sound-to-Light Interface	MAR '89	637 £6.24
Midi Pedal		639 £7.00
Midi Merge		640 £3.00
Audio Lead Tester		641 £5.77
Light Sentinel: Main Board	APR '89	632 £9.20
Remote Interface (4 bds)		633 £4.59
4-Channel Auto-Fader Interface		642 £6.80
Electron A/D Interface	MAY '89	645 £4.84
Spectrum EPROM Programmer	JUNE '89	628 £7.87
Programmable Pocket Timer	JULY '89	648 £3.82
Electronic Spirit Level	AUG '89	649 £3.85
Distance Recorder		651 £5.23
Xenon Beacon	SEP '89	650 £4.13
Probe Pocket Treasure Finder		653 £4.12
Power Supplies: Fixed Voltage		654 £4.08
Variable Voltage		655 £4.48
Music on Hold	OCT '89	646 £3.85
Power Supplies - 25V 700mA		656 £4.35
30V 1A		657 £4.55
EE Seismograph - Control		658 £4.08
Detector		659 £4.22
Lego/Logo & Spectrum		660 £6.49

PCB SERVICE

See opposite page for ordering details.

PROJECT TITLE	Order Code	Cost
Wash Pro NOV '89	643	£3.83
Biofeedback Monitor – Front End	661	£4.52
Processor	662	£4.56
Logo/Lego & Spectrum Interface	664	£5.60
EEG Electrode Impedance Meter DEC '89	665	£3.98
Biofeedback Signal Generator JAN '90	666	£4.08
Quick Cap Tester FEB '90	668	£3.92
Weather Stn: Anemom. – Freq./Volt Board	670	£3.94
Optional Display	669	£3.73
Wind Direction	673/674	£4.22
System Power Supply	675	£3.59
Prophet In-Car Ioniser	676	£3.18
Weather Stn: Display Driver MAR '90	672 & 678	£4.22
Display and Sensor	671	£4.47
Fermostat Mk2	677	£4.28
Superhet Broadcast Receiver/Tuner/Amp	679/680	£4.22
Stereo Noise Generator APR '90	681	£4.24
Digital Experimenter's Unit – Pulse Generator	682	£4.46
Power Supply	683	£3.66
Enlarger Timer	684	£4.28
Weather Stn: Rainfall/Sunlight Display	685	£4.27
Rainfall Sen and Sunlight Sen	686/687	£4.16
Amstrad Speech Synthesiser MAY '90	689	£4.68
80 Metre Direct Conversion Radio JUN '90	691	£4.95
Mains Appliance Remote Control JUL '90		
Encoder Board A	694	£6.61
Encoder Board B	695	£4.78
The Tester	696	£4.15
Mains Appliance Remote Control AUG '90		
Mains ON/OFF Decoder	697	£4.55
(5 or more 697's ordered <i>together</i> £3.25 each)		
Simple Metronome	698	£3.94
Hand Tally: Main Bd and Display Bd SEP '90	699, 700	£10.95
Alarm Bell Time-Out	701	£4.10
Mains Appliance Remote Control		
Temperature Controller (p.c.b. only)	702	£5.20
Ghost Waker OCT '90	703	£4.32
Frequency Meter	704	£5.25
Freq. Meter/Tachometer NOV '90	705	£3.98
EE Musketeer (TV/Video/Audio)	706	£5.78
Colour Changing Christmas Lights DEC '90	707	£4.39
Microcontroller Light Sequencer	708/709	£10.90
Versatile Bench Power Supply Unit	710	£4.24
Teach-In '91, Part 1 – L200 Module	711	£3.93
Dual Output Module	712	£4.13
LM723 Module	713	£4.21
Spatial Power Display JAN '91	714	£5.33
Amstrad PCW Sound Generator	715	£5.03
Teach-In '91, Part 2 – G.P. Transistor Amp	717	£3.77
Dual Op.Amp Module	718	£3.83
Intercom (Teach-In '91 Project 2) JAN '91	719	£4.41
Analogic Test Probe	720	£3.24
MARC Phone-In FEB '91	721	£6.87
Teach-In '91 Part 3 – TBA820M Amplifier	723	£4.05
High Quality Power Amp	724	£4.93
Bench Amplifier (Teach-In '91 Project 3)	725	£4.45
Gingernut 80m Receiver FEB '91		
R.F. section (726), Voltage Regulator (727)	726/7/8	£3.06
Audio Amplifier (728)	all 3 together	per board £8.16
Pocket Tone Dialler MAR '91	729	£4.36
Battery To Mains Inverter	730	£4.97
Simple Basic Alarm	731	£4.50
Car Code Lock (pair)	732a/b	£4.69
Teach-In '91 Part 4 – MAR '91		
Sinusoidal Oscillator	733	£4.39
8038 Oscillator	734	£4.15
Waveform Generator (Teach-In '91 Project 4)	735	£4.72
Humidity Tester APR '91	716	£4.97
Model Train Controller (double-sided)	736	£9.75
Electronic Die (Teach-In '91 Project 5)	737	£4.93
Teach-In '91 Part 5 – Digital Counter Module	738	£4.35
Modular Disco Lighting System MAY '91		
Switched Power Output Module	739	£5.91
Digital LCD Thermostat–Control Board	740	£4.05
–Power/Relay Board	741	£3.76
Pulse Generator (Teach-In '91 Project 6)	742	£4.97
Teach-In '91 Part 6– Timer Module	743	£4.62

PROJECT TITLE	Order Code	Cost
Digilogue Car Tachometer JUN '91	744	£5.63
Modular Disco Lights – Simple Chaser	745	£5.00
Sweeper Module	746	£5.17
Automatic Light Control – PSU Board	747	£4.88
Logic Board	748	£5.17
Radio Receiver (Teach-In '91 Project 7)	749	£4.57
Teach-In '91 Part 7 – R.F. Amplifier Module	750	£4.23
Modular Disco Lights – Masterlink JULY '91	752	£6.36
Ultrasonic Proximity Meter		
Display Unit (753) & Sensor Unit (754)	753/754	£7.06
Disco Lights (Teach-In '91 Project 8)		
PSU and Pre-amplifier	755	£4.54
Low, Mid, High Filter/Triac (set of 3 boards)	756	£11.00
Teach-In '91 Part 8 – Solid State Switch Module	757	£4.24
Mod. Disco Lights – Pattern Gen AUG '91	760	£6.79
Teach-In '91 Part 8–Light Sensitive Switch	761	£4.74
Opto-Link (Teach-In '91 Project 9) – Transmitter	762	£4.85
Receiver	763	£4.88
Portable PEsT Scarer	764	£3.77
Capacitance Meter SEP '91	751	£5.17
Modular Disco Lights – Dimmer Interface	765	£8.17
Mod. Disco Lights OCT '91		
VU Sound Module (Double-sided)	767	£8.68
UV Exposure Unit	768	£4.63
PC-Scope Interface – Main Board	769	£6.95
Expansion Plug (Double-sided)	770	£5.96
Mod. Disco Lights NOV '91		
Superchaser (Double-sided)	771	£6.91
Supersweep (Double-sided)	772	£8.26
Bicycle Alarm	773	£5.01
Darts Scorer	774	£7.90
Knockerbox DEC '91	775	£5.35
Signal Generator – Main Board	776	£7.46
PSU	777	£4.73
Mind Machine – Main Board	778	£7.00
Auto Nightlight	779	£5.03
Mind Machine – Programmer Board JAN '92	780	£7.39
Transistor Checker	781	£4.63
Stepping Motor Driver/Interface	782	£10.39
Micro-Sense Alarm	783	£5.42
Telesound FEB '92	784	£4.66
Programmable Timer	785	£4.63
Auto Garage Light MAR '92	786	£6.10
Versatile BBC Computer Interface	787	£11.59
Economy Seven Timer	788	£5.20
Sonic Continuity Tester APR '92	789	£4.79
Telephone Ringer	790	£5.46
Experimental Weighing Scale MAY '92	792	£5.17
12V Drill Charger/PSU (both boards)	793	£5.31
Digital Servo Interface JUNE '92	791	£4.73
Tie Pulsar	794	£5.19
CCD Reverb Unit	795	£6.39
Switch-Mode Power Supply	796	£7.01
UV Exposure Timer JULY '92	797	£5.33
Cricket Game	798	£6.77
Quick Prom	799	£5.61

EE PRINTED CIRCUIT BOARD SERVICE

Order Code	Project	Quantity	Price
------------	---------	----------	-------

Name.....

Address.....

I enclose payment of £ (cheque/PO
in £ sterling only to
Everyday Electronics)
Access (MasterCard) or Visa No.
Minimum order for credit cards £5

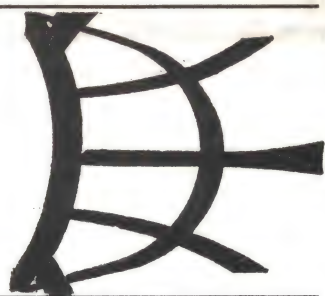


Signature..... Card Ex. Date.....

Please supply name and address of card-holder if different from the address shown

REPORTING AMATEUR RADIO

Tony Smith G4FAI



RSGB OPEN HOUSE

The Radio Society of Great Britain threw open its doors on Saturday 11th April to show-off to members its newly re-vamped headquarters at Potters Bar, Herts. Previously, visitors to HQ, including myself, had commented on the rather unwelcoming aspect of the reception/enquiries area and the feeling of being kept at bay from "their" society.

Now everything is changed. A light spacious reception and shop area with friendly staff draws visitors right inside the building. Close at hand is a small but interesting museum with radio equipment, home-made and commercial, dating from earlier days of amateur radio. Adjacent to this is a well-equipped radio station, callsign GB3RS, which licensed members can operate by arrangement.

Visitors were taken round the headquarters' accommodation, including the editorial offices of the Society's journal, *Radio Communication*, which nowadays is produced by the latest "new technology" processes. To put members "in the picture" about just what goes on at Potters Bar the tour extended to the membership department, the various offices and even the accounts department.

Of great interest was the QSL bureau which is the service used most frequently by most members. Here, thousands of QSL cards pour in each week for sorting and onward transmission in bulk to other bureaux at home and abroad, for eventual delivery to individual amateurs in confirmation of radio contacts made. Down in the basement, what is effectively a small warehouse holds and dispatches all RSGB publications and other radio books purchased by mail order, with the income earned providing a useful supplement to the Society's funds.

SERVICES PROVIDED

Like most of the visitors, I was impressed and reassured by what I saw. When one is a member of any society from a distance it is easy to get a wrong impression about what goes on at headquarters. There have been rumblings in recent years about the need for a more open Society but recent changes, typified by this open day, augur well for the future.

Apart from paid staff at headquarters, around 800 volunteers provide specialist services for members such as QSL sub-bureaux, an audio-visual library, organisation of operating awards and contests, technical advice, advice and help on interference problems, propagation predictions, exhibitions and conventions, help in obtaining planning permission for antennas, news bulletins, slow Morse training broadcasts, Morse tests for licences, provision of radio beacons and repeaters, Novice training courses and much more.

The greatest benefit in having a national society, however, arises from

the fact that although amateur radio is a hobby it is governed by national and international regulations which define not only the radio communication modes which can be used, and the nature of the communications allowed, but also the frequencies allocated to amateurs.

DEFENDING FREQUENCIES

These frequencies are under constant threat as commercial and broadcast radio services seek to expand, and an absolutely essential link is maintained by the RSGB with the DTI's Radiocommunications Agency, Britain's radio licensing authority. This ensures that the needs of amateur radio are taken into account whenever frequency allocations or licensing conditions are discussed by the authorities at either national or international level.

Without a national society to maintain such a link it is doubtful if amateur radio could survive in today's cut-throat world of radio communication where a single frequency in commercial terms is estimated to be worth millions of pounds. The strange thing is that not all amateur operators seem to understand this and only about half the country's licensed amateurs are members of the RSGB. The other half, presumably, just haven't thought about the implications or are content to let the others do whatever is necessary on their behalf!

Membership of the Society is open to anyone interested in amateur radio, whether licensed or unlicensed. Further information can be obtained from RSGB, Lambda House, Cranborne Road, Potters Bar, Herts EN6 3JE.

YOUTH IN ACTION

Denby Dale Amateur Radio Society's annual "Youth in Action" weekend will be held on 14 to 16th August. This ambitious presentation of amateur radio to young people involves inviting Novice trainees, Scouts, Guides and ATC members to take part in amateur radio related activities arranged over the whole weekend plus some social activities.

These events take place in a field at Crosland Moor, conveniently located for radio purposes at 1000 feet a.s.l., where caravans, tents and marquees are installed for the weekend, including special event amateur radio station, GB2YIA.

Last year's activities included explanatory talks, simple construction projects, radio fox hunting, Morse instruction, radio operating with contacts as far away as Australia, USA and Japan, including opportunities for attendees to chat to the overseas operators, and experiments with a kite antenna. Additionally, there was an evening barbecue entertained by a local pop group.

It appears that "a good time was had by all" and I am told by Tony Galvin, G0DDB, that planning for this year's

event is proceeding well. "The idea is to keep everything fairly simple and let the young people actually make a useful piece of equipment, e.g. a crystal set. We also have ideas for a Morse exercise which should be quite fun."

RADIO BYGONES

There seems to be a lot of interest nowadays in the radio of the past. Apart from pure nostalgia, perhaps this is because in the "old days" it was fairly easy to look at a faulty circuit, identify components used for specific functions, replace them and get the set going again whether it was commercially or home-made. This can still be done, old components can still be obtained and it is often possible to restore 50/60 year old, or even older, wireless sets to their former glory.

I was reminded of the techniques of early home-construction by a piece in *Radio Bygones*, a magazine devoted to the radio art of the past. An article in the February/March 1992 issue describes the technique of "breadboarding" where all components are assembled and screwed down on a thick board and connected up with stiff wire laid out in straight lines around the board. Large diameter coils, glowing valves, brass fittings, large meters mounted in ebonite front panels, all evoke the atmosphere of the past and the article suggests ways of re-creating your own authentic or individual masterpiece – or maybe just a glorious Spiders' Nest!

Edited by Geoff Arnold, G3GSR, *Radio Bygones* is a high quality authoritative publication which covers all aspects of early wireless, transmitting and receiving – professional, amateur and domestic, with superb colour photographs helping to bring the whole subject to life.

Examples of recent articles show the range of subjects covered. "Wireless on RMS Queen Mary" provided an in-depth survey of the design and installation of the equipment on this famous liner. A photo-feature illustrated a collection of domestic receivers from the 1950s-60s located at the Bampton Museum of Communication and Domestic and Local History in Devon. Other, self-explanatory, titles included "Birth and Growth of Pye Radio Ltd", "From Cat's Whisker to Integrated Circuit", "Starting a (vintage radio) Collection", "The Vintage Years of Amateur Wireless" and "Saved by Radio – Evolution in Air-Sea Rescue radio transmitters".

For anyone interested in the history of radio, or collecting those beautiful radios of yesteryear, this wide-ranging magazine is a "must". Obtainable by mail only from *Radio Bygones*, 9 Wetherby Close, Broadstone, Dorset BH18 8JB, the annual subscription, for 6 issues, is £17. A sample copy can be obtained at a special price of £2.50 if you mention EE when writing.

APPROVED 418MHz UHF RADIO SWITCHING

A high quality ready to use radio control system consisting of a small UHF key fob transmitter with digital encoder and a UHF receiver housed in a custom made case with digital decoder and open collector transistor output. The codes of each transmitter and receiver are factory set, (can be changed by user). Available as a single or dual channel system. The transmitters are DT1 approved to MPT 1340. Applications include: Vehicle Security, Door Access Systems, Remote Controlled Lighting, Garage Door Opener, Security Devices, etc.

TRANSMITTER		RECEIVER	
Size - Key Fob	SINGLE CH	Size (Case)	60 x 65 x 25mm
Voltage/Batt.	50 x 35 x 13mm	Size PCB	47 x 55 x 15mm
Circuit	12V Alkaline	Code Selection	Solder Trace
Encoding	2 Stage Saw	Voltage	9-16V dc
Combinations	12 Bit Trinary	Outputs	Open Collector
Code Selection	531.441	Output Drive	500mA
	8 Bit Trinary	Sensitivity	-88dBm (typical)
	6.561		
	Solder Trace		
Single Channel TX & RX	£39.99	Individual	TX £24.99, RX £19.99
Dual Channel TX & RX	£45.99	Individual	TX £27.99, RX £22.99

All Prices Include VAT - Please add £1.50 P&P per order.

Credit Card Orders: Tel. 021 4111821 or Fax 021 4112355

Cheques/PO's to:

QUANTEK ELECTRONICS LTD.,
3 Houldey Road, West Heath, Birmingham, B31 3HL.

VISA



TEST EQUIPMENT MAINTENANCE AND TECHNICAL CONSULTANCY

- ☐ Service manuals
- ☐ Spare parts
- ☐ Comprehensive repair service including complete instrument refurbishment at highly competitive rates for radio amateurs

Distributors for:
WAUGH INSTRUMENTS
RAMTEST LTD
KRENZ ELECTRONICS

- ☐ We support scientific, commercial and industrial equipment manufactured by over 100 different companies
- ☐ New and second-hand test equipment also available at competitive prices
- ☐ Components, valves and miscellaneous items

Hesing Technology 

41 Bushmead Road, Eaton Socon, St. Neots, Cambs PE19 3BT
Telephone and Fax: (0480) 214488

Millions of quality components at lowest ever prices!

Plus Tools, Watches, Fancy Goods, Toys.
Mail order UK only.

All inclusive prices -
NO post, or VAT etc to add on.
Send 34p stamped self addressed label or envelope for catalogue/clearance list.

At least 2,100 offers to amaze you.

Brian J Reed
6 Queensmead Avenue, East Ewell
Epsom, Surrey KT17 3EQ
Tel: 081-393 9055

A. C. ELECTRONICS SURVEILLANCE?

Easy-Build Kits or Built Units.

Microtransmitter, 15mm x 25mm, received on standard VHF radio; kit £5.99, built £9.99 (picks up whispers and transmits up to 1/2 mile). Telephone transmitter, can be hidden in handset; kit £5.99, built £9.99. "Stinger" shock circuit, can run off 9V battery, unpleasant shock, originally for electric fences etc; kit £11.99, built £19.99. Lots of locksmith tools, transmitters in calculators, plug-in adaptors, alternative technology plans, surveillance kits etc.

Send 4 x 1st class loose stamps for list - Cheque/POs to:

A.C. ELECTRONICS, Dept. E.E.
53, WOODLAND WAY, BURNWOOD,
STAFFS WS7 8UP.

CREDIT CARD ORDERS: 0543 676477 (24 hours).

MAIL ORDER ONLY.

Devices not licenceable or BT approved.

CONTROL PORT for PCs

This I/O Port follows the general approach of the 'INTERFACING to PCs' series in this mag, BUT allows user's prototype control circuitry to be set up and run OUTSIDE the PC.

The double sided pcb fits into an I/O slot, and a ribbon cable terminating in a D-25 plug allows the control of projects with little risk to the PC. On board facilities include: 8-bit A-D, 8-bit D-A, 8 inputs, 8 latched outputs, 3 strobes and 1 IRQ.

Available as:

- (a) Etched double sided board with full instructions for drilling/assembly/testing using BASIC.....**£12.50**
- (b) Complete I/O card with ribbon cable and BASIC test programs. (Built and tested).....**£29.00**

Also available: Test pod with D-25 socket providing analogue and digital test signals/outputs for the I/O card, with BASIC test programs on disc.....**£17.00**

All above prices include P&P. Mail Order only from:

R. BARTLETT,
17, LIME TREE AVENUE, TILE HILL,
COVENTRY CV4 9EY

CAMBRIDGE COMPUTER SCIENCE LIMITED

LCD modules.....	16 char by 1: £4.00, 20 char by 2: £6.00, 40 char by 1: £8.00
5.25" Disk Drives, 80 Tk, DSD	£25.00 each
5.25" Disk Drives, 80 Tk, DSD Used, No Wty	£9.00 each
(The £15.00 drives are sold on a strictly "as is" basis)	
5.25" Disks, DSD, 48tpt, boxes of 10 (free disk cleaner with 5 boxes)	£5.00/box
Digital multimeter, 14 ranges, inc. leads & manual	£16.00 each
Apriort Disk drive PSU 5V @ 2.5A, 12V @ 2A	£10.00 each
5V @ 6A PSU	£4.80 each
5V @ 10A PSU	£6.40 each
Disk Drive Data lead BBC Micro to Disk Drive(s)	Single 2.00 Dual £4.00 each
Disk Drive Power lead BBC Micro to Disk Drive(s)	Single 2.00 Dual £4.00 each
8086 CPU chips	£2.00 each
280A CPU, CTC, PIO	£1.20 each; DMA £2.00; £4.50 all 4
77128 EPROMs (ex equipment)	£1.20 each or £5.00/5
256K DRAM (ex equipment)	£0.40 each
1MBit-10 DRAM (ex equipment)	£1.40 each
256K Byte DRAM Modules, removed from equipment	£6.00 each
16, 18 & 20 pin dll low profile IC sockets 0.3" wide	£0.40/10; £5.00/100
22 & 24 pin dll low profile IC sockets 0.4" wide	£0.40/10; £5.00/100
24, 28, 32, 40 & 48 pin dll low profile IC sockets 0.6" wide	£0.40/10; £5.00/100
Circuit tester, finds faults in TTL & CMOS logic circuits, inc leads	£8.00 each
Metal project boxes drilled & painted but unused 28 x 32.5 x 5cm	£5.00 each
Used computer cards many useful components (large ones socketed)	
Floppy disk card (NEC FDC chip) £1.00, Wini controller (WD HDC chip)	£1.00 each
CPU card (8086, 280 & EPROMs)	£3.00 each
Keyboards, full Qwerty, number pad and LCD	£8.00 each
Desktop computer case with 200W mains PSU (used)	£30.00 each

Prices include postage. Add 50p (plus VAT) to orders below £5.00. All items new unless stated.

Add 17.5% VAT to all prices. Send an SAE for our latest list or for more info.

Dept EE, 374 Milton Road, Cambridge CB4 1SU

Tel: 0223 424602, 0831 430496 or 0831 430552 (Mail order only)



New for 1992

★ **New MOSFET Amplifiers**
improved range of SMOS modules
30W, 30+30W, 60W, 120W

★ **20 watt Class A Amplifier**

★ **Low profile PCB Transformers**
a range of encapsulated transformers
4VA, 6VA, 10VA, 18VA, 24VA, 30VA

Write or phone for data and prices...
which include details of standard range of toroidal transformers and audio modules.

No price increase for 1992

Jaytee Electronic Services

143 Reculver Road, Beltinge, Herne Bay, Kent CT6 6PL
Telephone: (0227) 375254. Fax: (0227) 365104

EVERYDAY ELECTRONICS

CLASSIFIED

EE reaches twice as many UK readers than any other independent monthly hobby electronics magazine, our audited ABC sales figures prove it. EE has been the leading independent monthly magazine in this market for the last seven years

If you want your advertisements to be seen by the largest readership at the most economical price our classified and semi-display pages offer the best value. The prepaid rate for semi-display space is £8 (+ VAT) per single column centimetre (minimum 2.5cm). The prepaid rate for classified adverts is 30p (+ VAT) per word (minimum 12 words).

All cheques, postal orders, etc., to be made payable to Everyday Electronics. VAT must be added. Advertisements, together with remittance, should be sent to the Classified Advertisement Dept., Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. Tel: (0202) 881749.

For rates and information on display advertisements ('eth page and larger spaces) please contact our Advertisement Manager, Peter Mew on 0255 850596.

MAURITRON TECHNICAL PUBLICATIONS

The following is a selection from our vast range of Technical Manuals for the TV and Video Servicing Trade. Order some today.

Order Code	Title	Price
MTP-5	Video Recorder Faults - Repair Guide	£1.95
MTP-58	VHS Video Recorder Principles	£1.95
MTP-7	Transistor Radio Repair Guide	£1.00
MTP-34	TTL Integrated Circuits Databook	£4.95
MTP-10	CMOS Integrated Circuits Databook	£4.50
VHCK	Video Head Cleaning Kit	£3.50
MTP-9	Power Supplies & Voltage Regulators	£2.95
MTP-24	Transistor Equivalents and Testing Manual	£4.50
MTP-8	Record Player Speed Disc	£0.95
MTP-19	Telephone SDT Code Location Guide	£3.95

SERVICE MANUALS. We can also supply Service manuals for most equipment. Audio, TV, Video, Test etc. etc. Please enquire.

All orders plus £2.35 post and packing

Hundreds of other Repair and Data Guides available from our Catalogue available FREE upon receipt of a stamped envelope and sent with all orders.

MAURITRON PUBLICATIONS (EE2)

8 Cherry Tree Road
Chinnor
Oxfordshire OX9 4QY
Tel: (0844) 51694 Fax: (0844) 52554

N. R. BARDWELL LTD (EE)

200	Signal diodes 1N4148	£1.00
75	Rectifier Diodes 1N4001	£1.00
75	Rectifier Diodes 1N4003	£1.00
50	Rectifier Diodes 1N4007	£1.00
56	Rectifier Diodes 1N5401	£1.00
10	NE555 Timer i.c.s	£1.00
5	741 Op Amp i.c.s	£1.00
8	C106D1 400V 6 amp thyristors	£1.00
8	BFY51 Transistors	£1.00
30	BC478 Transistors	£1.00
30	MPSA92 Transistors	£1.00
25	Asstd. high brightness i.e.d.s	£1.00
50	Axial i.e.d.s (Diode package) wide angle red	£1.00
50	Rectangular red i.e.d.s	£1.00
20	Miniature axial i.e.d.s super bright red	£1.00
24	Miniature red i.e.d.s 3mm dia	£1.00
12	Asstd. seven segment displays	£1.00
43	Com. anode seven segment displays	£1.00
100	22NF 100V radial film capacitors	£1.00
100	33NF 50V radial film capacitors	£1.00
200	Asstd. disc ceramic capacitors	£1.00
80	4U7 16V Radial electrolytics	£1.00
75	4U7 63V Radial electrolytics	£1.00
90	10U7 16V Radial electrolytics	£1.00
50	10U7 50V Radial electrolytics	£1.00
80	22U7 25V Radial electrolytics	£1.00
60	33U7 16V Radial electrolytics	£1.00
60	22U7 50V Radial electrolytics	£1.00
50	47U7 50V Radial electrolytics	£1.00
90	100U7 10V Radial electrolytics	£1.00
50	22U7 16V Radial electrolytics	£1.00
40	47U7 10V Radial electrolytics	£1.00
60	100U7 10V Radial electrolytics	£1.00
40	Asstd. IF transformers	£1.00
48	Asstd. coil formers	£1.00
100	Asstd. RF chokes	£1.00
30	Asstd. di sockets up to 40 pin	£1.00
30	Assorted socket/conn's/edge-dil-sil-etc.	£1.00
20	1 inch Glass reed switches	£1.00
10	4P 3W MBB min. rotary switches	£1.00
20	Min SP/CO slide switches	£1.00
20	Magnetic ear pipe plus lead & plug	£1.00
1	Peltier effect heat pump	£1.95
1	10 watt Stereo amplifier, 4 controls plus data	£2.95
1	10mm Flashing i.e.d. red	£0.75
1	10mm Ultra bright i.e.d. red 300 MCD	£0.60

Prices include VAT, postage £1.00. Stamp for Lists

288 Abbeydale Road, Sheffield S7 1FL
Phone (0742) 552886. Fax (0742) 500689

RCS VARIABLE VOLTAGE D.C. BENCH POWER SUPPLY

1 to 24 volts up to 1/2 amp. 1 to 20 volts up to 1 amp. 1 to 16 volts up to 1 1/2 amps d.c. Fully stabilised. Twin panel meters for instant voltage and current readings. Overload protection.
Fully variable.
Operates from 240V a.c.
Compact Unit.
Size 9 x 5 1/2 x 3 in.
NEW MODEL. Up to 38volts d.c. at 6 amps, 10 amps peak. Fully variable.
Twin panel meters. Size 14 1/2 x 11 x 4 1/2 in. £95 inc VAT. Can E6.



£45 inc. VAT
+ Post and insurance £4

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, CROYDON
SURREY, U.K. Tel: 081-684 1665

List, Large SAE. Delivery 7 days. Callers welcome. Closed Wednesday

NEW VHF MICROTRANSMITTER KIT

Tuneable 80-135MHz, 500 metre range, sensitive electret microphone, high quality PCB.
SPECIAL OFFER complete kit ONLY £5.95
Assembled and ready to use £9.95 post free.
Access/Visa orders telephone 021 411 1821
Send 2x1st class stamps for Catalogue. Cheques/P.O.s payable to:

QUANTEK ELECTRONICS LTD
Kits Dept. (EE), 3 Houlday Road, West Heath,
Birmingham B31 3HL
SHOP NOW OPEN - CALLERS WELCOME

VERY INTERESTING DESIGNS

FOR ALL REASONS AND SEASONS
Wide selection of extremely useful kits and ready-made products for home, workshop and outdoors, at reasonable prices.
Ring or Write for FREE literature

BECKER SYSTEMS

Dept EE27, 8 Finucane Drive, Orpington
Kent BR5 4ED. Tel: 0689 837821 (24 hrs)

THE BRITISH AMATEUR ELECTRONICS CLUB
exists to help electronics enthusiasts by personal contact and through a quarterly Newsletter. For details, write to the Chairman:

Mr H. F. Howard, 41 Thingwall Park
Fishponds, Bristol BS16 2AJ
Space donated by Everyday Electronics



Cooke International FOR SALE

Scopes, Signal Generators, Power Supplies, Power Meters, DVM's, Oscillators, Attenuators, etc. Used Test Equipment

We can now offer a copy service for workshop manuals for many instruments. Please ask for details.

Contact: Cooke International, Unit 4,
Fordingbridge Site, Main Road, Barnham,
Bognor Regis, West Sussex PO22 0EB

Open: Mon-Fri 9am-5pm or phone

0243 545111 - Fax: 0243 542457

Wide range of items available. Send SAE for lists

Miscellaneous

KITS, PLANS, ETC for surveillance, protection (sonic, HV), "007" gear. Send 2 x 22p stamps for list. ACE(EE), 53 Woodland Way, Burntwood, Staffs.

G.C.S.E. ELECTRONICS KITS at pocket money prices. S.A.E. for FREE catalogue. SIR-KIT ELECTRONICS, 70 Oxford Road, Clacton CO15 3TE.

PROTOTYPE PRINTED CIRCUIT BOARDS one offs and quantities, for details send s.a.e. to B. M. Ansbro, 38 Poyning Drive, Sussex BN3 8GR, or phone Brighton 720203.

STUDY ELECTRONICS on the BBC Micro. An interactive approach to learning. Three program titles now available 'Introduction to Electronics Principles', 'Electronics Mathematics' and 'Digital Techniques'. Programs include theory, examples, self test questions, formulae, charts and circuit diagrams. User inputs and calculated outputs, £29.95 each plus £2pp. Cheque or Postal Order to E.P.T. Educational Software, Pump House, Lockram Lane, Witham, Essex CM8 2BJ. Please state BBC B/Master series and disc size.

SATELLITE CHANNEL REPORT. 32 pages documenting transponder video, audio and data on every satellite within your range worldwide, updated monthly. Available as single issue or by subscription. Call: DTL 0491 681502. Fax: 0491 681944

OSCILLOSCOPE. Tequipment D56 double beam, double timebase, variable sweep delay with Tektronix adjustable trolley £150. Also Tequipment DM53A storage 'scope £100. Both good condition with manuals. Packing and carriage extra. Tel 0322 330556 (N. Kent)

Electronic Product Consultant

We are a Hong Kong manufacturer looking for an innovative enterprising person to design and develop small electronic products on a project by project basis in his spare time. Preferably someone with relevant production experience. If you want the chance to make your ideas pay don't let this opportunity of working together with us pass you by.

Please reply with your full details to:

Mike Hill, Hill Products Ltd
PO Box 98777
T.S.T. HONG KONG

Mini F.M. transmitter, sensitive built-in microphone. Range 100 metres. Runs for weeks on 2AA cells.
Ready built on p.c.b. with battery holder £4.50
Boxed with switch £7.50

Detailed information sheet on request.
Personal stereo tape players, with headphones.
Complete, but probably have minor faults £2.00 each to clear
Less headphones £1.00

PLEASE ADD 50p PER ORDER POSTAGE - MAIL ORDER ONLY
Livewireless, 25 Halsall Road, Birkdale
Southport, Lancashire PR8 3DB

Looking for a home study course, in the fundamentals of electronics? Whether you are a beginner, or an old hand requiring a refresher, the

DIRECT PERSONAL LEARNING

course, could be right for you. Contact:

K. Sparrow

(Electronic Training Consultant)

11 Claydon Green, Whitchurch, Bristol,
Avon BS14 0NG. Tel: 0275 835669

LOW PRICE ACCESS TO MULTI-SATELLITE TV EQUIPMENT FOR THE ENTHUSIAST
S.C.KU Band, LNB's, Receivers, Polarisers, Actuators, 60cm-1.8m Dishes, Feedhorns
All leading brands supplied. Mail Order Only
NEW & GUARANTEED

A.E.S. SYSTEMS

Send SAE stating your requirements

13 Combe Av, Portishead, Bristol BS20 9JR

Typical prices are: Echostar SR50 £153 + P&P

MTI Full Band LNB 1.3db £160 + P&P

Enquiries from Schools & Colleges Welcome

OSCILLOSCOPE Hameg HM203-7. Little used, still under warranty, £220. Precision Gold digital multimeter M810, almost new £27. 0822 834367.
FOR SALE Leak 100 amplifier, pre-amp and 110V transformer - Heathkit short wave receiver G.R.64, collectors items. Sensible offers only to 0597 851517.

BTEC ELECTRONICS TECHNICIAN FULL-TIME TRAINING

THOSE ELIGIBLE CAN APPLY FOR E.T. GRANT SUPPORT AN EQUAL OPPORTUNITIES PROGRAMME

O.N.C., O.N.D. and H.N.C.

Next course commences

Monday 21st September 1992

FULL PROSPECTUS FROM

LONDON ELECTRONICS COLLEGE
(Dept EE) 20 PENYWERN ROAD
EARLS COURT, LONDON SW5 9SU
TEL: 071-373 8721

SOLAR PANELS

Special offer 12V nom (20V o/c) 80mA. 12" x 6" pre wired Amorphous Silicon panel £4.50 includes P&P. Many other sizes, wind generators and other products.

Orders to (Cat 2 x 1st class stamps)

Robert Keys, 4 Glanmor Crescent
Newport Gwent NP9 8AX

BTEC qualifications

'NEC's courses
are generally
recognised as
among the best
in Open
Learning'
The Guardian

- Electronics
- Telecommunications
- Microelectronics

For further information contact:

Dept 702
National Extension College
18 Brooklands Avenue
Cambridge CB2 2HN
Tel: (0223) 316644



BY OPEN LEARNING

COMPONENTS
For TV ★ Video
Audio ★ Computer

WE CAN SUPPLY A VAST RANGE OF SPARES for many
makes of TV, Video, Computer & Audio Equipment. WRITE
(Encl. s.a.e. please) or PHONE
FOR A 'PRICE & AVAILABILITY'
on your requirements. **0452 526883**

VIDEO BELT KITS	
AMSTRAD VCR4600/4700/5200	£3.19
FISHER FVH905/906/908	£3.03
JVC HR3300/3330/3660	£3.30
SANYO VTC6500	£2.23
SERVICE MANUALS	
BINATONE 01/9771	£6.99
PHILIPS KTA/K40 Chassis	£12.50
PHILIPS CM6033 (Mk 1)	£3.90
SEMICONDUCTORS	
TBA530 £1.74 UPC1378H	£2.45
TDA1001B £3.86 ZTX650	£0.49
OTHER ITEMS	
SHARP RGF281/4 Main belt	£1.40
TOSHIBA STU2 Mains transformer	£9.99
FIDELITY 14"/16"/20" General LOPTX (+ PCB)	£17.65
AMSTRAD VCR4500/4600 Pinch Roller Mod Kit	£9.48

This is just a small sample of stock. Please
send 3 x 18p stamps for our catalogue or
request a free copy with first order.

Order by Post or Phone. We accept payment
by VISA, ACCESS, DELTA, SWITCH, Cheque
or P.O. Post & Packing is £1.20. No VAT to
add on.
All items subject to availability.
Prices can change without notice.

COMPUTER SPARES

AMSTRAD/SINCLAIR		ATARI	
PEGA1A (PC1640)	£30.85	CO25913 DMA (ST)	£33.24
40010 G. Array	£18.86	User Manual (STFM)	£10.00
PCW9512 Serv. Manual	£14.49	PC900V/H11L3 (ST)	£2.88
CP0464 Serv. Manual	£8.67	ROM Basic (XE/L)	£4.58
AY38912	£7.06	THERMISTOR (ST-PSU)	£1.37
SED9420CAC	£14.93	CNY65 (ST-PSU)	£2.42
TEA2000	£4.49	PC713V (STE-PSU)	£2.94
TMS4532-NL4	£1.72	2SC2331 (ST-PSU)	£1.59
ULA6C001E	£17.61	COMMODORE	
ULA7K010/400056	£16.72	17.7344MHz Xtal	£4.99
ZX8302(OL)	£10.98	C64C User Manual	£4.39
ZX8401	£7.94	C64 User Manual	£4.25
Spec. + 2 ROM	£16.69	6510 CPU	£10.03
Spec. 48k Speaker	£1.74	6526 CIA	£11.11
Spec. 48k Membrane	£4.73	6569 VIC	£19.95
+128k Membrane	£8.39	8520 Amiga	£11.25
28 way Edge Conn.	£3.56	8565 VIC	£23.96
QL Membrane	£8.99	908114-01 PLA	£9.24
EPSON		251641-02 PLA	£4.06
C78010B0031 CPU	£30.24	MB81416-12 DRAM (C16)	£4.99



MARAPET (EEG)
1 HORNBEAM MEWS
GLOUCESTER GL2 0UE

Carbon Film resistors 1/4W 5% E24 series 0.51 R to 10MΩ	1p
100 off per value - 75p. even hundreds per value totalling 1000	£6.00p
Metal Film resistors 1/4W 10R to 1 MΩ 5% E12 series - 2p. 1% E24 series	3p
Mixed metal/carbon film resistors 1/4W E24 series 1R0 to 10MΩ	1 1/2p
1 watt mixed metal/Carbon Film 5% E12 series 4R7 to 10 Megohms	5p
Linear Carbon pre-sets 100mW and 1/4W 100R to 4M7 E6 series	7p
Miniature polyester capacitors 250V working for vertical mounting	
015, 022, 033, 047, 068-4p. 0.1 - 5p. 0.12, 0.15, 0.22 - 6p. 0.47 - 8p. 0.68 - 8p. 1.0 - 12p	
Mylar (polyester) capacitors 100V working E12 series vertical mounting	
1000p to 8200p - 3p. 0.01 to 0.68 - 4p. 0.1 - 5p. 0.12, 0.15, 0.22 - 6p. 0.47/50V - 8p	
Submin ceramic plate capacitors 100V wkg vertical mountings. E12 series	
2% 1.8pf to 47pf - 3p. 2% 56pf to 330pf - 4p. 10% 390p-4700p	4p
Disc/plate ceramics 50V E12 series 1P0 to 1000P, E6 Series 1500P to 47000P	2p
Polystyrene capacitors 63V working E12 series long axial wires	
10pf to 820pf - 5p. 1000pf to 10,000pf - 6p. 12,000pf	7p
741 Op Amp - 20p. 555 Timer	20p
cmos 4001 - 20p. 4011 - 22p. 4017	40p
ALUMINIUM ELECTROLYTICS (Mfds/Volts)	
1/50, 2.2/50, 4.7/50, 10/25, 10/50	5p
22/16, 22/25, 22/50, 47/16, 47/25, 47/50	6p
100/16, 100/25 7p; 100/50 12p; 100/100	14p
220/16 8p; 220/25, 220/50 10p; 470/16, 470/25	11p
1000/25 25p; 1000/35, 2200/25 35p; 4700/25	70p
Submin. tantalum bead electrolytics (Mfds/Volts)	
0.1/35, 0.22/35, 0.47/35, 1.0/35, 3.3/16, 4.7/16	14p
2.2/35, 4.7/25, 4.7/35, 6.8/16 15p; 10/16, 22/6	20p
33/10, 47/6, 22/16 30p; 47/10 35p; 47/16 60p; 47/35	80p
VOLTAGE REGULATORS	
1A + or - 5V, 8V, 12V, 15V, 18V & 24V - 55p. 100mA 5.8, 12, 15, V +	30p
DIODES (piv/amps)	
75/25mA 1N4148 2p. 800/1A 1N4006 4 1/2p. 400/3A 1N5404 14p. 115/15mA OA91	8p
100/1A 1N4002 3 1/2p. 1000/1A 1N4007 5p. 60/1.5A S1M1 5p. 100/1A bridge	25p
400/1A 1N4004 4p. 1250/1A BY 127 10p. 30/15A OA47	10p
Zener diodes E24 series 3V3 to 33V 400mW - 8p. 1 watt	12p
Battery snaps for PP3 - 6p for PP9	12p
L.E.D.'s 3mm. & 5mm. Red, Green, Yellow - 10p. Grommets 3mm - 2p. 5mm	2p
Red flashing L.E.D.'s require 9-12V supply only	50p
Mains indicator neons with 220k resistor	10p
20mm fuses 100mA to 5A. O. blow 5p./A/surge 10p. Holders, chassis, mounting	6p
High speed pc drill 0.8, 1.0, 1.3, 1.5, 2.0mm - 30p. Machines 12V dc	£7.00
HELPING HANDS 6 ball joints and 2 croc clips to hold awkward jobs	£3.50p
AA/HP7 Nicad rechargeable cells 90p each. Universal charger unit	£6.50p
Glass reed switches with single pole make contacts - 8p. Magnets	12p
0.1" Stripboard 2 1/2" x 1" 9 rows 25 holes - 25p. 3 1/4" x 2 1/2" 24 rows 37 holes	70p
Jack plugs 2.5 & 3.5m	14p
Sockets Panel Mtg. 2.5 & 3.5m	10p
TRANSISTORS	
BC107/8/9 - 12p. BC547/8/9 - 8p. BC557/8/9 - 8p. BC182, 182L, BC183, 183L,	
BC184, 184L, BC212, 212L - 10p.	
BC327, 337, 337L - 12p. BC727, 737 - 12p. BD135/6/7/8/9 - 25p. BCY70 - 18p.	
BFY50/51/52 - 20p.	
BFX88 - 15p. 2N3055 - 50p. TIP31, 32 - 30p. TIP41, 42 - 40p. BU208A - £1.20, BF195, 197 - 12p	
Ionisers with seven year guarantee, list price £16.95	£12.50

All prices are inclusive of VAT. Postage 30p (free over £5). Lists Free.

THE CR SUPPLY CO
127 Chesterfield Rd., Sheffield S8 0RN
Tel: 0742 557771 Return posting

Technical Information Services

76 CHURCH STREET, LARKHALL, LANARKSHIRE, ML9 1HE

Tel. (0698) 884585 Mon-Fri 8.30am - 5.00pm

Tel. (0698) 883334 Outwith business hours

FAX facility available all day on both lines

Write now with an SAE for your

FREE QUOTE FREE VOUCHERS & FREE CATALOGUE

Remember, not only do we have EVERY service sheet ever produced,
but we also have

THE WORLDS LARGEST COLLECTION OF SERVICE MANUALS

& WE ARE SOLE SUPPLIERS OF VARIOUS FAULT-FINDING GUIDES
REPAIR MANUALS & TECHNICAL MANUALS

CTV, Video, CD, Hi-Fi, Camcorder, Satellites, Computers, Domestic Equip'...etc.

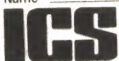
DATA REFERENCE MANUAL '...essential for the serious electrician'
FREE updating and a 10% discount voucher only £5.95
Incorporates Unique Model Identification and Chassis Data

MAKE YOUR INTERESTS PAY!

Over the past 100 years more than 10 million students throughout the world have found it worth their while! An ICS home-study course can help you get a better job, make more money and have more fun out of life! ICS has over 100 years experience in home-study courses and is the largest correspondence school in the world. You learn at your own pace, when and where you want under the guidance of expert 'personal' tutors. Find out how we can help YOU. Post or phone today for **FREE INFORMATION** on the course of your choice. (Tick one box only!)

Electronics	☐	TV, Video & Hi-Fi Servicing	☐
Basic Electronic Engineering (City & Guilds)	☐	Refrigeration & Air Conditioning	☐
Electrical Engineering	☐	Car Mechanics	☐
Electrical Contracting/Installation	☐	Computer Programming	☐
GCSE/GCE/SCE over 40 examination subjects to choose from			☐

Name _____ Address _____

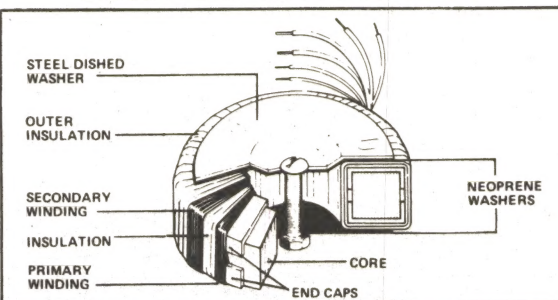


International Correspondence Schools Dept ECS 72
312/314 High Street, Sutton, Surrey SM1 1PR or 041-221 7373 (24 hours).



The UK Distributor for Standard Toroidal Transformers

- * 106 types available from stock
- * Sizes from 15VA to 625VA



Write or phone for free Data Pack

Jaytee Electronic Services

143 Reculver Road, Beltinge, Herne Bay, Kent CT6 6PL
Telephone: (0227) 375254

Metal detector boards with Data has tuner, mode, discriminate, headphone jack, on/off volume & push button facilities. **£7.95 ea***

Dictaphone cassette, mech/record erase playback heads, 6V solenoid, motor, hall effect switch. **£2.00 ea***

T.V./Printer stands. **£3.95 ea***

Bicc-Vero Easiwire construction kit. **£4.95 ea***

TTL/CMOS short circuit snooper. **£4.95***

Dot matrix LCD 10x2 lines. **£3.75 ea***

Dot matrix LCD 16 x 1 lines with Data. **£4.95***

40 characters x 1 line dot matrix LCD with data. **£15.00***

2 digit 16 segment VF display with data. **£2.95 ea***

4 digit intelligent dot matrix display. **£6.00***

17 segment V.F. display with driver board and data. **£2.99 ea***

8 digit liquid crystal display. **£1.75 ea***

4 digit LCD with 7211 driver chip. **£3.50 ea***

Digital clock display. **£2.50***

11 key membrane keypad. **£1.50 ea***

Keyboard 392mm x 180mm/100 keys on board + LCD + 74HC05/80C49 easily removable. **£4.95**

19" 3U sub rack enclosures. **£8.95**

12V stepper motor, 48 steps per rev, 7.3° step angle. **£3.95 ea***

Stepper motor board with 2 slotted opto + 2 mercury tilt switches. **£3.95 ea***

1000 mixed 1/4 watt 1% resistors. **£4.95 ea**

250 electrolytic axial + radial caps. **£4.95 ea**

200 off mixed polyester caps. **£7.95***

100 Mixed trimmer caps popular values. **£4.95***

100 off Phono plugs (red/black/grey). **£3.50***

50 Mixed terminal blocks. **£2.95**

25 off asst. buzzers & sounders. **£4.95***

Cable box UHF modulator/video preamp/transformer/R's + C's/leads. **£6.95**

1000 off mixed Multilayer Ceramic Caps. **£7.95**

Solar cell modules 0.45V 700mA. **£2.95 ea***

B.B.C. Micro to disc drive lead. **£1.50***

Car Burglar alarm vibration auto entry/exit delay. **£5.95 ea***

Single zone alarm panel auto entry/exit delay housed in domestic light socket. **£9.95 ea***

P.C. P.S.U. 50 watt 115-230V input + 5V 4A + 12V 2.5A output with built in fan, IEC inlet + on off. **£9.95 ea**

STC P.S.U. 240V input 5V 6A output (converts to 12V 3A details available). **£5.95 ea**

240V input 5V 10A output (converts to 12V 5A no details). **£5.95 ea**

6000 line output transformers. **£1.25 ea**

240V in 0-12V 0.75A out transformer. **£1.75***

240V in 0-28V 62VA out transformer. **£2.75**

Transformer + PCB gives 2x7.5V 32VA with skt for 5 or 12V regulator, will power floppy drive. **£3.75 ea**

Ultrasonic transducers (transmit + receive). **£1.50 pair**

3 to 16V Piezoelectric sounders. **50p***

9VDC electromechanical sounder. **50p***

24V DC electromechanical sounder. **50p***

2A 250V keyswitch 3 position key removable in two positions. **£1.50***

DIL switches PCB MT 3/4/6 way. **35p***

5V SPCO SIL reed relay. **40p***

5V 2PCO DIL miniature relay. **60p***

12V 2PCO or 4PCO continental relay. **60p***

12V 10A PCB MT (to make contact) relay. **95p***

3 to 12V electro magnetic acoustic transducer with data. **75p***

2.4576/8.8329/21.10 MHz crystals. **50p ea***

Bridges 25A 200V. **£1.00**

2A 100V. **50p***

3lb Mixed components pack. **£4.95**

25 off mixed relays. **£5.95***

40 off mixed toggle switches. **£9.95***

50 off mixed switches, toggle, rocker, slide, micro. **£9.95**

Miniature axial chokes 0.1, 0.18, 0.12, 0.33, 0.39, 0.15, 1, 3.3UH. **10p ea., 100 for £7.50***

250 off 16/22/24/40 way IC Skts. **£4.95***

Crystal Oscillators 10/24/48 MHz. **£1 ea***

Spider Plug Leads. **75p ea***

QUANTITY DISCOUNTS AVAILABLE PLEASE RING

ALL PRICES INCLUDE V.A.T. PLEASE ADD £2.00 p.p. EXCEPT ITEMS MARKED * WHICH ARE 50P. SAE FOR BULK BUYING LIST PAYMENT WITH ORDER TO

Dept EE, COMPELEC,
14 Constable Road
St. Ives, Huntingdon,
Cambs PE17 6EQ
Tel/Fax: 0480 300819

ADVERTISERS INDEX

A.C. ELECTRONICS.....	469	MAGENTA ELECTRONICS.....	408/409
N. R. BARDWELL.....	470	MAILTECH.....	417
R. BARTLETT.....	469	MAPLIN ELECTRONICS Cover (iv)	471
BK ELECTRONICS.....	469	MARAPET.....	471
BLB ELECTRONICS.....	406	MARCO TRADING.....	405
BRIAN J. REED.....	469	MAURITRON PUBLICATIONS	470
BULL ELECTRICAL.....	469	M&B ELECT. SUPPLIES.....	460
CAMBRIDGE COMP. SCIENCE.....	469	MODERN ELECTRONICS	
CIRKIT DISTRIBUTION.....	425	MANUAL.....	456/457
COMPELEC.....	472	NATIONAL EXTENSION COLLEGE.....	471
CRICKLEWOOD ELECTRONICS.....	451	NORTHERN MARKETING CONCEPTS.....	425
CR SUPPLY COMPANY.....	471	NUMBER ONE SYSTEMS.....	421
ECW INSTRUMENTS.....	404	OMNI ELECTRONICS.....	406
ESR ELECTRONIC COMPONENTS.....	410	PICO TECHNOLOGY.....	406
HART ELECTRONIC KITS.....	407	QUANTEK ELECTRONICS.....	469
HESING TECHNOLOGY.....	469	RACKZ PRODUCTS.....	406
ICS.....	471	SHERWOOD ELECTRONICS.....	472
JAYTEE ELECTRONIC SERVICES.....	469, 471	SUMA DESIGNS.....	402
JPG ELECTRONICS.....	406	TECHNICAL INFO. SERVICES.....	471
LASER SCIENCE.....	425	TSIEN.....	432
		TYPESETTING BUREAU.....	472

SHERWOOD ELECTRONICS

9 Lower Birchwood, Somercotes, Derbyshire DE55 4NG

★ ★ ★ SPECIAL OFFER ★ ★ ★

Choose any 2 packs FREE with every 10 £1 packs purchased.

SP1 15 x 5mm Red Leds	SP37 20 x 100uf/35V radial caps.
SP2 15 x 5mm Green Leds	SP38 25 x 47uf/25V radial caps.
SP3 12 x 5mm Yellow Leds	SP42 200 x Mixed 0.25W C.Film resistors
SP6 15 x 3mm Red Leds	SP44 12 x 5mm Leds-4 ea. Red, Grn., Yel.
SP7 12 x 3mm Green Leds	SP47 5 x Min. push button switches
SP8 10 x 3mm Yellow Leds	SP102 20 x 8 pin DIL sockets
SP10 100 x 1N4148 diodes	SP103 15 x 14 pin DIL sockets
SP11 30 x 1N4001 diodes	SP104 15 x 16 pin DIL sockets
SP12 30 x 1N4002 diodes	SP105 6 x 74LS00
SP18 20 x BC182 transistors	SP109 15 x BC557 transistors
SP20 20 x BC184 transistors	SP112 6 x Cmos 4093
SP23 20 x BC549 transistors	SP119 6 x Cmos 4072
SP25 5 x 555 timers	SP121 8 x Rect. Red Leds 5 x 2mm
SP26 5 x 741 Op-amps	SP122 8 x Rect. Green Leds 5 x 2mm
SP28 6 x Cmos 4011	SP123 5 x Rect. Yellow Leds 5 x 2mm
SP36 25 x 10uf/25V radial caps.	SP125 10 x 1000uf/16V radial caps

RESISTOR PACKS - 0.25W C.Film		
RP3 5 each value - total 365	£2.30	
RP7 40 each value - total 730	£3.95	
RP10 1000 popular values	£5.35	

Catalogue - price £1
Contains £2 vouchers redeemable against orders

Cheques or P.O. to **SHERWOOD ELECTRONICS** NO VAT Please add £1 P&P to all orders

Typefit

THE TYPESETTING BUREAU LTD

PC page make-up software and typesetter output bureau

"For serious document production it knocks other DTP software into the proverbial cocked hat."

Those are the words of Jim Tyler, an independent journalist after reviewing Typefit for "Micro Computer Mart". His letter to us went on to say:

"I spent two years editing a magazine, I have been involved in running a DTP bureau and I currently make my living writing classic car restoration manuals for a division of Reed Business International. I would choose Typefit for any of these roles."

No we did not pay him anything - he did not even get a free copy of our software (Typefit only costs £225 + VAT anyway). And just for the sceptics he is not a personal friend, relative or shareholder in the company.

His sentiments are backed up by our customers, some of which have changed from other well-known DTP packages costing much more - they tell us Typefit is more

versatile and provides them with use of a better range of quality typefaces (230 different fonts).

With Typefit you do your own Typesetting, proof and correct your work, we provide the expensive phototypesetter and fonts to give you top quality 2000 dot per inch bromide output.

Before investing in any other DTP package and especially before spending a small fortune on a specialist typesetting computer or other equipment, please investigate Typefit.

Please send me more information on Typefit

Name.....

Address:.....

Post Code.....

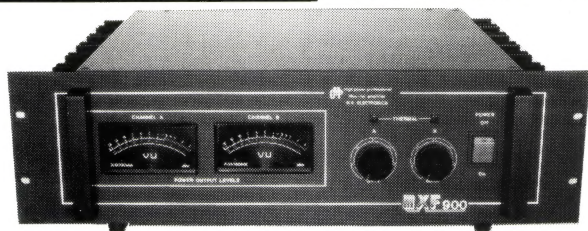
Tel:.....EE

MP POWER AMPLIFIER MODULES-TURNABLES-DIMMERS-LOUDSPEAKERS-19 INCH STEREO RACK AMPLIFIERS

* PRICES INCLUDE V.A.T. * PROMPT DELIVERIES * FRIENDLY SERVICE * LARGE (A4) S.A.E. 50p STAMPED FOR CATALOGUE *

MP MOS-FET POWER AMPLIFIERS 19 INCH POWER, TWO CHANNEL 19 INCH RACK

THOUSANDS PURCHASED BY PROFESSIONAL USERS



THE RENOWNED MXF SERIES OF POWER AMPLIFIERS

OUR MODELS:- MXF200 (100W + 100W) MXF400 (200W + 200W) MXF600 (300W + 300W) MXF900 (450W + 450W)

ALL POWER RATINGS R.M.S. INTO 4 OHMS, BOTH CHANNELS DRIVEN

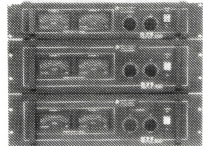
FEATURES: ★ Independent power supplies with two toroidal transformers ★ Twin L.E.D. VU meters ★ Volume controls ★ Illuminated on/off switch ★ XLR connectors ★ Standard 775mV inputs ★ Open and short circuit of ★ Latest Mos-Fets for stress free power delivery into virtually any load ★ High slew rate ★ Very low distortion ★ Aluminium cases ★ MXF600 & MXF900 fan cooled with D.C. loudspeaker and thermal protection.

USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC.

SIZES:- MXF200 W19"xH3 1/2" (2U)x D11"
MXF400 W19"xH5 1/4" (3U)x D12"
MXF600 W19"xH5 1/4" (3U)x D13"
MXF900 W19"xH5 1/4" (3U)x D14 1/2"

PRICES:- MXF200 £175.00 MXF400 £233.85
MXF600 £329.00 MXF900 £449.15

SPECIALIST CARRIER DEL. £12.50 EACH



MP VARISPEED TURNTABLE CHASSIS



★ Manual arm ★ Steel chassis ★ Electronic speed control 33 & 45 R.P.M. ★ Vari pitch control ★ High torque servo driven DC motor ★ Transit screws ★ 12" die cast platter ★ Neon strobe ★ Calibrated balance weight ★ Removable head shell ★ 1/2" cartridge fixings ★ Cue lever ★ 220/240V 50/60Hz ★ 390x305mm ★ Supplied with mounting cut-out template.

PRICE £61.30 + £3.70 P&P

OPTIONAL MAGNETIC CARTRIDGES

STANTON AL500mkII GOLDRING G950

PRICE £16.95 + 50P P&P PRICE £7.15 + 50P P&P

STEREO DISCO MIXER DJ6500

STEREO DISCO MIXER with 2 x 7 band graphic equalisers with bar graph VU meters. MANY OUTSTANDING FEATURES:- including Echo with repeat & control, DJ Mic with tone control talk-over switch, 7 Channels with individual faders plus cross fade, Cue headphone Monitor. Useful combination of following inputs:- 3 turntables (mag), 3 CDs, 5 Line for CD, Tape, Video etc.

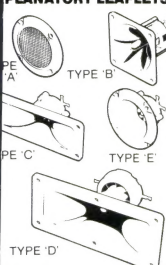
PRICE £134.99 + £5.00 P&P



SIZE: 482 x 240 x 120mm

PIEZO ELECTRIC TWEETERS - MOTOROLA

In the Piezo revolution! The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required, units can be added to existing speaker systems of up to 100 watts (more if two are put in series. FREE PLANNATORY LEAFLETS ARE SUPPLIED WITH EACH TWEETER.



TYPE 'A' (KSN1036A) 3" round with protective wire mesh. Ideal for bookshelf and medium sized Hi-Fi speakers. Price £4.90 + 50p P&P.
TYPE 'B' (KSN1005A) 3 1/2" super horn for general purpose speakers, disco and P.A. systems etc. Price £5.99 + 50p P&P.
TYPE 'C' (KSN1016A) 2" x 5" wide dispersion horn for quality Hi-Fi systems and quality discos etc. Price £6.99 + 50p P&P.
TYPE 'D' (KSN1025A) 2" x 6" wide dispersion horn. Upper frequency response retained extending down to mid-range (2KHz). Suitable for high quality Hi-Fi systems and quality discos. Price £9.99 + 50p P&P.
TYPE 'E' (KSN1038A) 3 1/4" horn tweeter with attractive silver finish trim. Suitable for Hi-Fi monitor systems etc. Price £5.99 + 50p P&P.
LEVEL CONTROL Combines, on a recessed mounting plate, level control and cabinet input jack socket. 85x85mm. Price £4.10 + 50p P&P.

MP LINNET LOUDSPEAKERS

THE VERY BEST IN QUALITY AND VALUE

Made especially to suit today's need for compactness with high output sound levels, finished in hard wearing black vinyl with protective corners, grille and carrying handle. Each unit incorporates a 12" driver plus high frequency horn for a full frequency range of 45Hz-20KHz. Both models are 8 Ohm impedance. Size: H20" x W15" x D12".

CHOICE OF TWO MODELS

POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET

OMP 12-100WATTS (100dB) PRICE £163.50 PER PAIR
OMP 12-200WATTS (200dB) PRICE £214.55 PER PAIR

SPECIALIST CARRIER DEL. £12.50 PER PAIR



N-CAR STEREO BOOSTER AMPS



PRICES: 150W £49.99 250W £99.99
400W £109.95 P&P £2.00 EACH

THREE SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS

150 WATTS (75 + 75) Stereo, 150W Bridged Mono
250 WATTS (125 + 125) Stereo, 250W Bridged Mono
400 WATTS (200 + 200) Stereo, 400W Bridged Mono

ALL POWERS INTO 4 OHMS

Features: ★ Stereo, bridgable mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

OMP MOS-FET POWER AMPLIFIER MODULES

SUPPLIED READY BUILT AND TESTED.

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heat sink, glass fibre P.C.B. and drive circuits to power a compatible VU meter. All models are open and short circuit proof.

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS



OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 123 x 60mm.
PRICE £40.85 + £3.50 P&P



OMP/MF 200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 155 x 100mm.
PRICE £64.35 + £4.00 P&P



OMP/MF 300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 330 x 175 x 100mm.
PRICE £81.75 + £5.00 P&P



OMP/MF 450 Mos-Fet Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
PRICE £132.85 + £5.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.



VU METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D.s (7 green, 4 red) plus an additional on/off indicator. Sophisticated logic control for very fast rise and decay times. Tough moulded plastic case, with acrylic tinted front. Size 84 x 27 x 45mm.
PRICE £8.70 + 50p P&P

LOUDSPEAKERS



LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLES, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLETS AND HORNS, LARGE (A4) S.A.E. (50p STAMPED) FOR COMPLETE LIST.

P - From McKenzie Professional Series
S - From McKenzie Studio Series

McKENZIE- INSTRUMENTS, P.A., DISCO, ETC

ALL McKENZIE UNITS 8 OHMS IMPEDANCE

8" 100 WATT P C8-100GP GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID, DISCO. RES. FREQ. 80Hz, FREQ. RESP. TO 7KHz, SENS 96dB. PRICE £31.45 + £2.00 P&P
10" 100 WATT S C10-100GP GUITAR, VOICE, KEYBOARD, DISCO, EXCELLENT MID. RES. FREQ. 72Hz, FREQ. RESP. TO 6KHz, SENS 97dB. PRICE £38.89 + £2.50 P&P
10" 200 WATT S C10-200GP GUITAR, KEYB'D, DISCO, EXCELLENT HIGH POWER MID. RES. FREQ. 69Hz, FREQ. RESP. TO 5KHz, SENS 97dB. PRICE £53.21 + £2.50 P&P
12" 100 WATT P C12-100GP HIGH POWER GEN. PURPOSE, LEAD GUITAR, DISCO. RES. FREQ. 49Hz, FREQ. RESP. TO 7KHz, SENS 98dB. PRICE £40.35 + £3.50 P&P
12" 100 WATT P C12-100TC (TWIN CONE) HIGH POWER, WIDE RESPONSE, P.A., VOICE, DISCO. RES. FREQ. 45Hz, FREQ. RESP. TO 12KHz, SENS 97dB. PRICE £41.39 + £3.50 P&P
12" 200 WATT S C12-200B HIGH POWER BASS, KEYBOARDS, DISCO, P.A. RES. FREQ. 45Hz, FREQ. RESP. TO 5KHz, SENS 99dB. PRICE £71.91 + £3.50 P&P
12" 300 WATT S C12-300GP HIGH POWER BASS, LEAD GUITAR, KEYBOARDS, DISCO ETC. RES. FREQ. 49Hz, FREQ. RESP. TO 7KHz, SENS 100dB. PRICE £95.66 + £3.50 P&P
15" 100 WATT P C15-100BS BASS GUITAR, LOW FREQUENCY, P.A., DISCO. RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS 98dB. PRICE £59.05 + £4.00 P&P
15" 200 WATT P C15-200BS VERY HIGH POWER BASS. RES. FREQ. 40Hz, FREQ. RESP. TO 3KHz, SENS 98dB. PRICE £80.57 + £4.00 P&P
15" 250 WATT S C15-250BS VERY HIGH POWER BASS. RES. FREQ. 39Hz, FREQ. RESP. TO 4KHz, SENS 99dB. PRICE £90.23 + £4.50 P&P
15" 400 WATT S C15-400BS VERY HIGH POWER, LOW FREQUENCY BASS. RES. FREQ. 40Hz, FREQ. RESP. TO 4 KHz, SENS 100dB. PRICE £105.46 + £4.50 P&P
18" 500 WATT S C18-500BS EXTREMELY HIGH POWER, LOW FREQUENCY BASS. RES. FREQ. 27Hz, FREQ. RESP. TO 2KHz, SENS. 98dB. PRICE £174.97 + £5.00 P&P

EARBENDERS- HI-FI, STUDIO, IN-CAR, ETC

ALL EARBENDER UNITS 8 OHMS (Except EB8-50 & EB10-50 which are dual impedance tapped @ 4 & 8 ohms)

BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED SURROUND
8" 50watt EB8-50 DUAL IMPEDANCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR. RES. FREQ. 40Hz, FREQ. RESP. TO 7KHz SENS 97dB. PRICE £8.90 + £2.00 P&P
10" 50watt EB10-50 DUAL IMPEDANCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR. RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS. 99dB. PRICE £13.65 + £2.50 P&P
10" 100watt EB10-100 BASS, HI-FI, STUDIO. RES. FREQ. 35Hz, FREQ. RESP. TO 3KHz, SENS 96dB. PRICE £30.39 + £3.50 P&P
12" 100watt EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO. RES. FREQ. 26Hz, FREQ. RESP. TO 3 KHz, SENS 93dB. PRICE £42.12 + £3.50 P&P
FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND
5 1/4" 60watt EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. RES. FREQ. 63Hz, FREQ. RESP. TO 20KHz, SENS 92dB. PRICE £9.99 + £1.50 P&P
6 1/2" 60watt EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. RES. FREQ. 38Hz, FREQ. RESP. TO 20KHz, SENS 94dB. PRICE £10.99 + 1.50 P&P
8" 60watt EB8-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. RES. FREQ. 40Hz, FREQ. RESP. TO 18KHz, SENS 99dB. PRICE £12.99 + £1.50 P&P
10" 60watt EB10-60TC (TWIN CONE) HI-FI, MULTI ARRAY DISCO ETC. RES. FREQ. 35Hz, FREQ. RESP. TO 12KHz, SENS 98dB. PRICE £16.49 + £2.00 P&P

TRANSMITTER HOBBY KITS

PROVEN TRANSMITTER DESIGNS INCLUDING GLASS FIBRE PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS COMPLETE WITH CIRCUIT AND INSTRUCTIONS

3W TRANSMITTER 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE, RANGE UP TO 3 MILES. SIZE 38 x 123mm, SUPPLY 12V @ 0.5AMP. PRICE £14.85 + £1.00 P&P

FM MICRO TRANSMITTER 100-108MHz, VARICAP TUNED, COMPLETE WITH VERY SENS FET MIC, RANGE 100-300m. SIZE 56 x 46mm, SUPPLY 9V BATTERY. PRICE £6.80 + £1.00 P&P

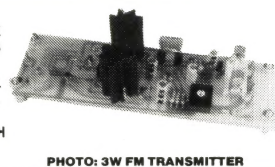


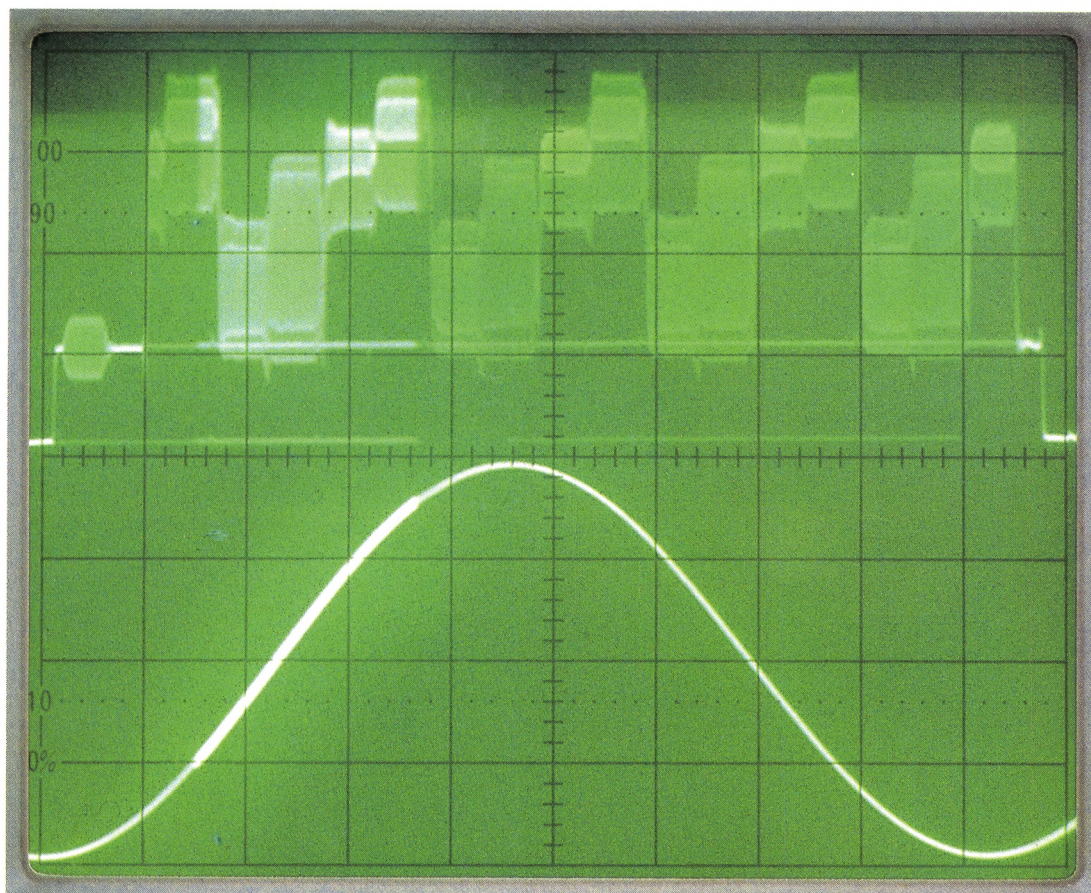
PHOTO: 3W FM TRANSMITTER

B.K. ELECTRONICS

UNITS 1 & 5 COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR.
Tel.: 0702 - 527572 Fax.: 0702 - 420243

POSTAL CHARGES PER ORDER £1.00 MINIMUM. OFFICIAL ORDERS FROM SCHOOLS, COLLEGES, GOV'T. BODIES, PLCs ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER. VISA AND ACCESS ACCEPTED BY POST, PHONE OR FAX.



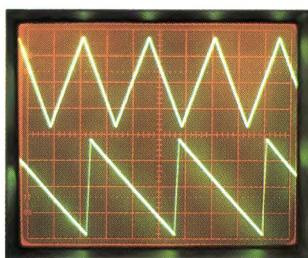


Let's talk waveforms...

...AND THE BEST IN OSCILLOSCOPES.

Our new range of precision laboratory oscilloscopes offer not only the best features, but also prices. From the sophisticated 20MHz 7025 to the delayed sweep 40MHz 7046, advanced design and high quality combine to bring you features such as; 1mV/div sensitivity, advanced 6-inch CRT with percentage markers and internal graticule, eliminating parallax error and ensuring a highly accurate display. X-Y mode allows Lissajous patterns to be produced and phase shifts measured.

The 7025 has all the capabilities required of a general purpose oscilloscope and will accept signals from DC to at least 20MHz with a high degree of accuracy. The 20MHz 7026 incorporates a delayed sweep time base, which can be used to magnify a portion of the waveform, and makes accurate time interval measurements and the study of short duration events



possible. The sophisticated 40MHz 7045 includes a 40ns delay line to help show very short duration events in their entirety. A delayed sweep oscilloscope of advanced design and high quality is found in the shape of the 40MHz delayed sweep 7046, having an increased magnification along with a 40MHz bandwidth and capable of displaying complex signals with precision and accuracy.

Full details of our oscilloscopes and all other test equipment can be found in the 1992 Maplin catalogue, available from **WHSMITH** or Maplin shops nationwide £2.75 or by post £2.95. Mail Order to: P.O. Box 3,

Rayleigh, Essex,
SS6 8LR. Credit
Card Hotline, 0702
554161 or visit
your local store.

Maplin
ELECTRONICS

GL29G [H] 20MHz scope 7025...£299.95. GL30H [H] 20MHz scope 7026 ...£349.95. GL31J [H] 40MHz scope 7045...£449.95. GL33L [H] 40MHz scope 7046...£499.95 (illustrated).

All items subject to availability. Handling charge £1. [H] Indicates carriage charge of £5.30. All prices inclusive of VAT.

Visit our stores at: **BIRMINGHAM**; Sutton New Road, Erdington. **BRIGHTON**; 65 London Road. **BRISTOL**; 302 Gloucester Road. **CARDIFF**; 29 City Road. **CHATHAM**; 2 Luton Road. **GLASGOW**; 264-266 Great Western Road. **LEEDS**; Carpet World Building, 3 Regent Street. **LEICESTER**; Office World Building, Burton Street. **LONDON**; 146-148 Burnt Oak Broadway, Edgware. 120-122 King Street, Hammersmith. **MANCHESTER**; 8 Oxford Road. **NEWCASTLE-UPON-TYNE**; Unit 4, Allison Court, The Metro Centre, Gateshead. **NOTTINGHAM**; 86-88 Lower Parliament Street. **READING**; 129-131 Oxford Road. **SHEFFIELD**; 413 Langsett Road, Hillsborough. **SOUTHAMPTON**; 46-48 Bevois Valley Road. **SOUTHEND-ON-SEA**; 282-284 London Road, Westcliff. Plus new stores in **COVENTRY** and **SOUTH LONDON** opening soon. Ring 0702 552911 for further details.

